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THE REBUILDING AND DOUBLE TRACKING OF THE PANAMA R. R.

By R. BUDD.*

The Panama R. R. from Colon to Panama is 47.7 miles long. In addition to this there is a branch two miles long from Panama to La Boca, the present ship landing and the Pacific terminus of the Panama Canal. The double track portion comprises two sections; one is from Culebra to Gatun (30 miles), for handling excavated material from the northern outlet of the Culebra cut to the various dumps and to the Gatun dam. The other is from Pedro Miguel to La Boca (7.2 miles) for handling excavated material from the southern outlet of the Culebra cut to the southern dumps and to the Sosa Corozal dam. From Colon to Gatun (7 miles) and from Culebra to Pedro Miguel (3½ miles) the railway is not being double tracked.

The portion double tracked is almost entirely built on embankment, so that the grading for double track presented an extremely simple and economical proposition; namely, that of unloading dirt trains from the Culebra cut along the main line, thus at once giving the Canal Commission a good dumping ground and providing a second track roadbed for the Panama R. R. There were a few cuts, the larger of which had to be taken out with steam-shovels. In order to avoid delays to the shovel and interruption to traffic that could not be eliminated from steam-shovel work, small pan cars (old French cars of the Decauville make) of ½-cu. yd. capacity, were used in all cases where the material could be disposed of within reasonable distance. Some of the smaller cuts were taken out with hand work and wheelbarrows. For the most part, the work of double tracking has been simply widening the original embankments sufficiently to support a new track, then moving the new track over to 13 ft. centers by unloading filling from the new track, and keeping it thrown over to the edge of the bank. The equipment used consisted of Western dump cars and flat cars unloaded by side-plow and Lidgerwood unloader. Both McCann and Jordan spreaders were used for leveling the fills.

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The enormous amount of track shifting required by this process, also the great amount of similar work being done on the Canal Commission dump tracks, led to the idea of building a machine especially for raising and shifting tracks. Fig. 1 shows the design of this track shifter, which is the invention of Mr. W. G. Bierd, General Manager of the Panama R. R., and for which he has taken out letters patent. It consists essentially of a double-drum hoisting engine, a horizontal boom and a vertical boom, all mounted on a car. The vertical boom is to lift the track, and the horizontal boom to shift it laterally. The amount of lateral throw it is possible to make with this machine depends entirely upon the amount of bend the rails will stand without breaking, as the machine is powerful enough to break 70-lb. rails at every throw.

VIEW OF TRACK-SHIFTING MACHINE IN USE ON THE PANAMA R. R.
Invented by W. G. Bierd, General Manager.

The view on this page shows the machine in use for shifting track to the edge of a widened embankment. It gives an idea of the heavy construction of the head frame and booms. It will be seen that the track has been slightly raised by hooks on a chain sling hung from the lifting boom. The shifting is done by means of a wire cable passing through the head of the shifting boom and atached to the inner rail b ya hook.

In practice the best results are obtained by making two hitches to each rail length of track; that is, throw 15 or 16 ft. of track at each move. By this method, track consisting of 70-lb. rails and 18 ties per rail length can be shifted laterally 4 ft. without injuring it. The machine backs away from the track as it is thrown, thus standing always on the old alinement. If it is desired to shift a track any considerable distance, requiring more than one throw, the machine is simply given additional runs over this stretch of the track, making a shift of 4 ft. each time. After the first run, however, it is not necessary to use the lifting boom, as track lying loosely on the dump (skeleton track) is pulled over 4 to 5 ft. easily without lifting. The Canal Commission has found these machines useful for raising tracks where dumping grounds are being developed, by laying track on the original surface and raising it until the required height is reached. Used in this way, only the lifting boom is required.

The crew required to handle one of the machines is as follows: 1 engineman, $125 per month; 1 fireman, $50; 1 foreman, $50; 4 laborers at 20 cts. per hour; locomotive engineman and conductor, $390 per month. This number of men, paid the rates given above, can move 6,000 ft. of track laterally 4 ft. in 8 hours, or at a cost of ½ ct. per lin. ft. The cost of doing a similar amount of work with lining bars and jacks will vary with different localities and conditions, but on the Isthmus it would require 250 men at 20 cts. per hour and 3 foremen averaging $100 per month. This would represent a cost of 8⅓ cts. per ft.

The track shifters now in use were made on the Isthmus, common flat cars being used, but the finished machine will be built on a special car and equipped with propelling gear the same as a locomotive crane, thus eliminating the expense of an engine and train crew.*

In locating the second track, it was shifted from one side to the other of the old main line at many places to better the alinement, to save cutting, or to improve the vision for safety in operation. At some places great improvements could be effected by surprisingly small effort.

*A track-throwing car which was tried on the Pennsylvania Lines was described and illustrated in our issues of Dec. 21, 1899, and Sept. 25, 1902. Editor Engineering News.

An instance of this is Bas Obispo, Fig. 2, where the old main line avoided a bend in the river by a curve which is now used for a house track behind the new station. This new station was built on a rock fill covering the old channel of the Obispo River, for which years and being gradually pulled out of shape by settlement of embankments and the tendency of trackmen to line track "out" when repairing and re-lining a curve without stakes. In some cases compound curves varying from 3° to 8° in spots were replaced with simple curves, siderable quantity of gravel loaded d... the rainy season. Fig. 5 shows a skid ...vator which is probably the best machine ... tried under these conditions, as it is able ... begin loading in the shortest time after th... floods recede and the loading tracks are rep...d. A

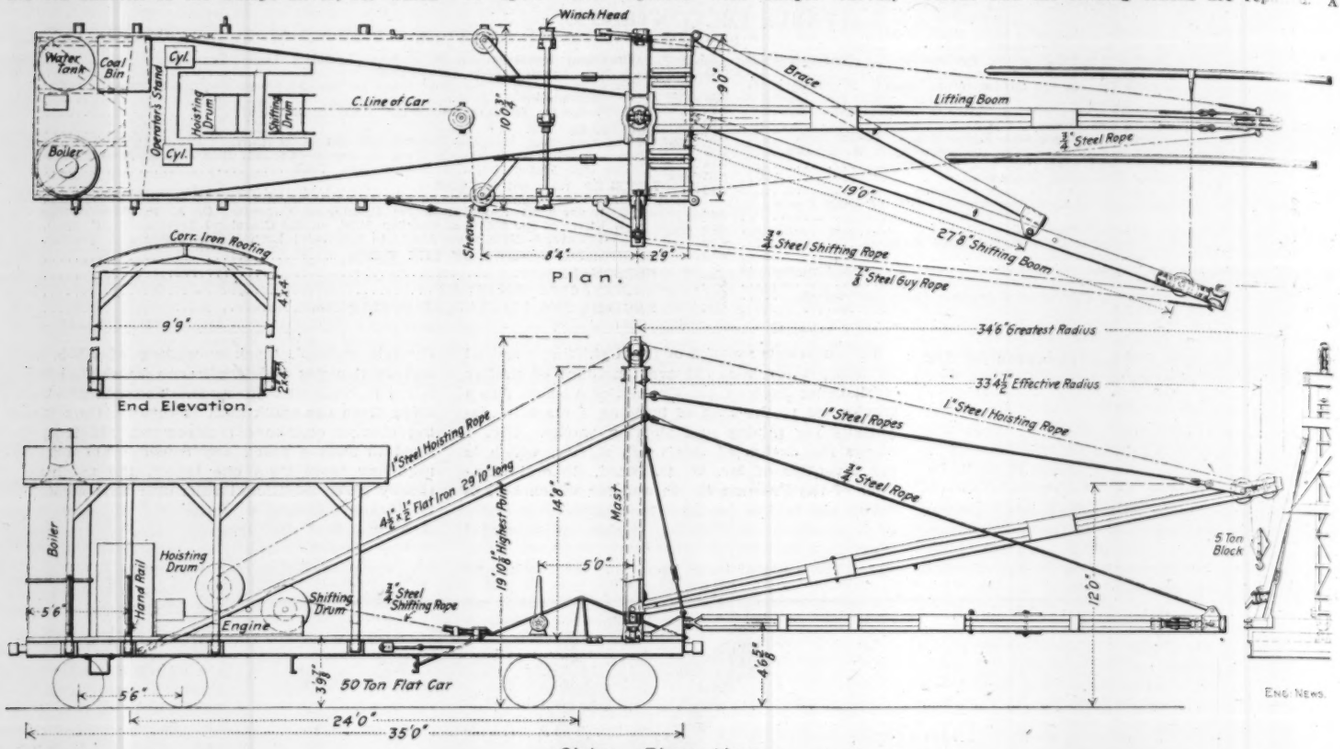


FIG. 1. TRACK SHIFTING CAR; PANAMA R. R.

a diversion channel was built, as shown. Fig. 3 shows the station and tracks, looking toward Colon. The curved house track at the right is the old main line. By way of contrast, the view in Fig. 4 is shown; this was taken almost exactly a year before that in Fig. 3, and from nearly the same point. The same two palm trees are shown at the right in each photograph, and the same spot in the track is shown by a cross in each.

Fig. 2 shows typical alinement of the old main line and is interesting as an example of the result of curves not being re-centered for many spiraled. In rebuilding the old line and double tracking it, all curves of 3° and over have been fitted with spirals on Talbot's system.

One of the most difficult features of rebuilding and double tracking the Panama R. R. has been the procuring of ballast in the required quantities. The Chagres River has a few deposits of excellent gravel, but during the rainy season (May 1 to Jan 1) the river is liable at any time to a rise of 5 ft. to 15 ft. in a few hours. It is difficult to get a plant which will load gravel promptly after such floods recede, but it is necessary to do this in order to get any con-

locomotive crane was successfully used during the last wet season by keeping the track on which the crane operated always connected with the main pit track, so that in case of sudden high water the crane could be taken out of the pit quickly. The one serious objection to the locomotive crane is that it requires one track for the cars being loaded and a parallel track for the crane to operate on; so that after floods there are two tracks instead of one to repair. At the beginning of the dry season three gravel pits were opened, a steam shovel being used in one, a locomotive crane in another, and the skid

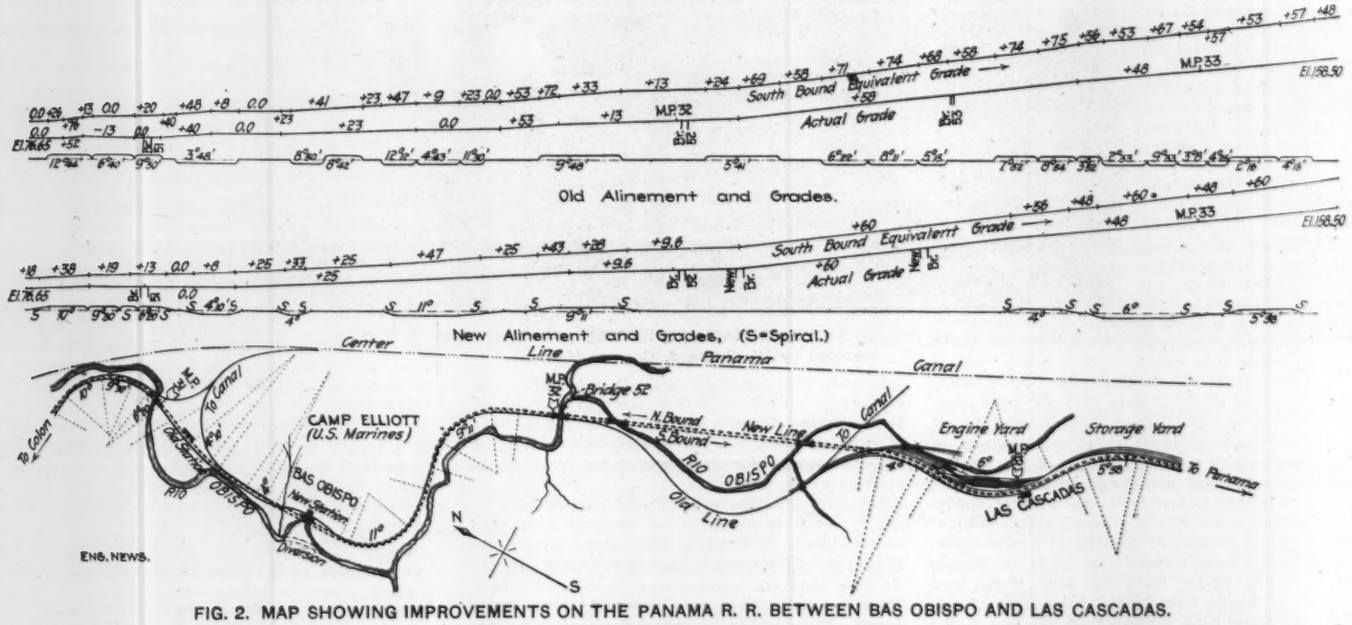


FIG. 2. MAP SHOWING IMPROVEMENTS ON THE PANAMA R. R. BETWEEN BAS OBISPO AND LAS CASCADAS.

dredge in the third. The operation of these pits in February and March, 1907, is shown in the accompanying table; April will show about the same operation as March.

During the wet season it costs 60 to 70 cts. per yd. to load gravel on account of the frequent washouts and in order to avoid extensive loading during the next wet season a storage pile of gravel has been made at Gorgona. This contains about 20,000 cu. yds. of excellent gravel, and can be loaded with a steam shovel for about 10 cts. per yd. when needed during the rainy season.

In relaying the old line and building the double track, 70-lb. rails of the Am. Soc. C. E. section have been used, but on the part of the road between the Culebra cut and the large dump at Tabernilla, this rail is proving to be entirely too light and will have to be replaced within 18 months after being laid.

Pile bridges were used on the second track throughout. In order to avoid interruption to traffic, the pile-driver was spurred out on the second track embankment. Where the bridges were very short, however, the piles were driven from the machine standing on the old main line. There are 65 bridges in all, from 12 to 150 ft. in length. A single exception to the above is the bridge across the Chagres River at San Pablo which consists of six 108-ft. girder spans. The double track is carried across this bridge by a gantlet track, No. 12 frogs being used and trains being operated under the protection of electric automatic signals.

The Atlantic terminal yards are completed, except the Mt. Hope material yard. These entire terminals are built on ground made by placing 3 to 5 ft. of filling on a coral reef. Most of this filling was obtained by working steam shovels in hills around Mt. Hope, but a great deal was hauled from the shovels excavating for the locks at Gatun. At the Pacific terminal at La Boca, a spur track from the new yards is proposed to enable the old docks to be used temporarily after the present access to them is precluded by the construction of the Sosa Corozal dam. The site of the permanent La Boca terminal is now partly

FIG. 4. PANAMA R. R. AT BAS OBISPO (APRIL, 1906).

(The white cross in Figs. 3 and 4 indicates the same point in both views.)

salt marsh and partly a mud flat, varying 22 ft. from high tide to low tide levels. It is being developed by the Canal Commission as a dumping ground, thus disposing of excavation from the Culebra cut and filling in the site for the new terminal.*

The double tracking is finished except for a distance of five miles south of Gatun, which it will require about a month to complete. As the second track has progressed from station to station, the outlying permanent crossover has been used for the end of the double track, as shown by Fig. 6. This view also shows the north end of passing tracks at Bohio, and in the background the old Panama R. R. standard station with shed roof. One of the new standard stations is shown in Fig. 3. These are 30 x 126 ft.;

FIG. 3. PANAMA R. R. AT BAS OBISPO (APRIL, 1907).

the passenger, office and freight sections being 30, 20 and 76 ft. long respectively. The passenger room is not enclosed, as will be noticed in the view. Five living rooms are provided upstairs for the agent. These stations cost about $4,500 on the Isthmus.

Of considerable more magnitude, and presenting more difficulties than building the new second track, has been the rebuilding of the old main line and rebuilding and enlarging the station sidings and passing tracks to accommodate the new demands. There are no especially interesting features connected with this part of the work, except the old main line alinement already mentioned, but it may be interesting to know that on some sections of the road between the larger dump grounds and the Culebra cut the average daily train movement since Feb. 1 has been about 75 in each direction, from 6 a. m. to 7 p. m., and as many as 90 train movements have been handled. Panama R. R. freight trains are run at night, generally about four in each direction. Grade changes involving raising track 2 to 3 ft. in places, renewing 70% of the ties in the old main line, relaying the rail in the old track and shifting to new alinement, all had to be carried on and that without causing material delay to this traffic.

During the past year 60,000 new ties and 75,000 cu. yds. of ballast have been used in the old main line. Seven miles of new passing tracks, 20 miles of new yard tracks and 11 new stations have been built.

*An article on the rail and shipping terminal facilities of the Panama R. R., and the improvements in these facilities to accommodate the increase in regular traffic and that due to the canal work, was published in our issue of May 24, 1906. Editor Engineering News.

STANDARD WHEELS AND RAILS for electric railways were reported upon by a committee at the May meeting of the Central Electric Railway Association at Indianapolis, Ind. The wheel is 4 3-16 ins. wide over all, 3 ins. from the outer face to the gage line; slope of tread 1-16 in. in 2 9-16 ins.; fillet radius, ½-in.; depth of flange, ⅞-in. This design can be operated on both city and interurban lines. For city tracks, a 7-in. 91-lb. T-rail is recommended, with a 2¾-in. head, 6-in. base and ½-in. web. For interurban tracks, a 70-lb. rail of the American Society of Civil Engineers section is recommended.

TWO POWERFUL, HIGH-SPEED CHAIN-DRIVES worthy of note have recently been installed—one at the plant of the Seattle Brewing & Malting Co. at Seattle, Wash., the other at Columbia, S. C., under the supervision of Mr. Wm. M. Piatt, Assistant City Engineer there. Both are of the type known as the Renold Silent Chain drive, of which the Link-Belt Co., of Philadelphia, are the American manufacturers.

The first, to which belongs the distinction of being the largest Renold Silent Chain drive ever installed in this country, consists of a 325-HP. parallel transmission to refrigerating machinery; two chains are run side by side on single wheels 14 ft. from center to center, the load being uniformly distributed by means of Dodge spring-centers on the driven wheel. The speed of this chain is 1,100 ft. per min.

The second is a single strand Renold chain driving a Worthington centrifugal pump from a horizontal turbine; the driving and driven wheels in this transmission are set 11 ft. 7 ins. from center to center, and the chain speed is 1,755 ft. per min. This drive is rated at 225 HP.

COST OF GRAVEL PIT EXCAVATION BY DIFFERENT METHODS: PANAMA R. R.

Location.	Method of excavation.	Output, cu yds.	Cost of Loading—Labor.	Supplies.	Total.	Per cu. yd.
February, 1907:						
Mamei	Loco. crane	$6,975	$1,288.62	$85.25	$1,373.87	$0.19.7
Gorgona	Stm. shovel	15,480	2,806.00	169.15	2,975.15	.19.2
Matachin	Skid dredge	6,860	1,265.00	150.99	1,415.99	.20.6
Total		$29,315	$5,359.62	$405.39	$5,765.01	$0.19.7
March, 1907:						
Mamei	Loco. crane	$7,978	$1,452.85	$225.53	$1,678.38	$0.21.0
Gorgona	Stm. shovel	15,237	2,031.35	209.04	2,240.39	.14.7
Matachin	Skid dredge	14,112	2,236.91	319.36	2,556.27	.18.1
Total		$37,327	$5,721.11	$753.93	$6,475.04	$0.17.3

A NEW CLEARANCE-MEASURING CAR FOR THE BALTIMORE & OHIO R. R.

By J. H. MILBURN.*

It has only been within recent years that the size of rolling stock began to increase to an extent requiring careful measurements for clearance. The clearance at first was limited by tunnels only, but owing to the increased size of engines, cars and special freight loads, it was found

FIG. 5. SKID DREDGE EXCAVATING GRAVEL FOR BALLAST FROM THE CHAGRES RIVER.

necessary to measure all obstructions, such as platforms, bridges, cattle guards, etc, as well.

A large portion of the Baltimore & Ohio system passes through very mountainous territory, and has under operation branches that were built many years ago, with tunnels cut through solid rock. The tunnels at the time of building were of ample size, but some have since been enlarged, lined or otherwise changed, and this, in addition to the constantly increasing size of rolling stock, make it essential that all clearances be accurately obtained, so that the maximum size of rolling stock can be safely handled.

The method of obtaining tunnel clearances previous to the year 1885 was as follows: Three or four men with ladder, torches, tape and plumb line walked through a tunnel, and any point appearing close was located by lateral measurements from plumb line over center of tracks, and the height measured from rail. The tedious method, danger from moving trains and unsatisfactory results are apparent.

Another method was tried in 1885 by using a segment board graduated in degrees to the right and left from a vertical line through the center. This was fastened on a board that rested on each rail; a bolt at the center engaged the end of an extension rod, graduated somewhat similar to the Philadelphia level rod. If on a curve the outer elevation was obtained, then the distance to the close point measured by the extension rod, noting the angle from the center line on segment board, which would be, when set, at right angles to a line across the top of the two rails. This measuring device is shown in Fig. 1. This method, while an improvement over the former, was still dangerous, slow, and gave results of doubtful accuracy. Both methods were almost useless as made apparent by observations taken on a tunnel car next tried, when it was found that some of the close points were overlooked in the earlier inspections.

About 1889 a measuring car was devised giving composite clearance. An old box car was used with a frame fastened on the sides and top. Into this frame were placed removable lead pipes about two feet in length and one foot apart. In running through a tunnel, the pipes would bend in hitting an obstruction and retain this position. As the frame was located in the center of car, the measurements taken on curves would give clearance for cars of same truck centers as the testing car. Corrections were then made for ordinates of cars with different truck centers.

The experience gained in the operation of this car resulted in a design of a car on the lines of the present one which was constructed in 1902 and used over the entire system, proving successful and giving accurate results at comparatively little expense. It was built on old flat car, with truck centers of 26 ft., a standard caboose was placed on the rear end, and the measuring device constructed on the front end towards the engine.

This car although giving excellent results proved rather light for proper handling and in the course of time required so much attention, partly due to age of car body, that it was deemed advisable to construct a new car.

In the new car, which has just been finished, the same principle was adhered to, with some changes and additions, both in design and method of construction.

DESCRIPTION OF CAR.

The principle of the car is very simple. At one end of a flat car is erected a framework of the same general shape as the outline of a car-body. On this framework are placed at intervals of 6 ins. outstanding arms, 24 ins. long, free to move in the direction of the track. Upon coming in contact with any obstruction these arms turn back a certain amount. The distance of the obstruction from certain fixed points can be read directly on a dial on the inside of the arm and the clearances thereby plotted.

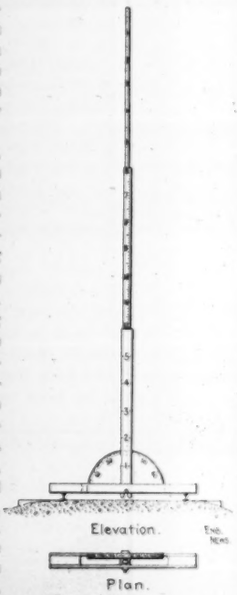


Fig. 1. Clearance Measuring Rod Used on Baltimore & Ohio R. R., 1886-87.

Fox pressed-steel, four-wheel trucks were used, with malleable side-bearing pockets and adjustable side-bearing shoes, and bolsters of two 1 × 10-in. plates. By using these adjustable bearings the oscillation of car and measuring frame can be reduced to a minimum. Six Georgia pine sills were used, viz.: two center and two intermediate, size 5 × 8 ins. each, and two outside, size 6 × 12 ins. Six truss rods 1⅛ in. diameter, three on each side with 12-in. chamber rod stands or queen posts. End sills were made of 10-in. oak, with 2 x 10-in. footboard; 2-in. oak was used for floor having a camber across the car of 1 in. for its full length, for drainage. An improved draft gear was built with 5x7 major couplers and continuous draft timbers extending through bolsters and connecting with sub-sills running entire length of car. The car is fitted with Westinghouse air brake, also signal attached to front of caboose and about six feet from floor.

The measuring device is located at center of forward truck so that all measurements refer to center line of track. It is constructed entirely of steel with two 4-in T-bars bent, as shown in drawing, with butt joint at top and spliced. The brackets for holding measuring arms are made of ⅝-in. material riveted to frame, at a distance of 6-in. between each pair. Great difficulty was experienced with the old car in obtaining measurements as low as was desirable, on account of the lower brackets being in the way of platforms, etc. This is overcome in the present plan, by turning and riveting the three lower brackets on each side of the car to the web of the T, using a different design of bracket than that used on the main frame; so that a graduated arm from any part of the main frame can be used. The extensions holding these lower brackets are bolted on so that they can be removed when shipping the car.

The frame is secured by the web of the T-bar being bolted between two plates which are bent

FIG. 6. END OF DOUBLE TRACK AND PASSING SIDINGS OF PANAMA R. R. AT BOHIO (APRIL 1, 1907).

*Chief Draftsman, B. & O. R. R., Baltimore, Md.

to an angle of 90° and the leg bolted to the side sills. The top of the frame is held in position by two 3-in. angles, extending from middle of frame at top to the ends of the front end sill. Similar bracing is not used on the rear of frame, as it would be in the way of those operating the car. This, however, is not necessary, as the car is always operated with frame next to engine, and all strain in the top of frame due to contact of arms is resisted by the two braces as shown. The frame is also braced on each side by four 3-in. angles at a point directly under the elevated platform and fastened to side sills.

The arms are ⅜-in. thick, 24-in. long from center of hole to point; with a semi-circular head, cut to radius of 3 15-16-in., on which is stamped a dial by which the distance of obstruction to the center of hole in head can be read. They are held in the brackets by ¾-in. bolts, using a thin washer between each side of arm and brackets, and tightened by wing nuts, so that the friction can be regulated, allowing each arm when in contact with an obstruction, to be forced backward and remain in that position until reading is taken.

All steel is painted black except the dials on head of arms, which are painted with aluminum paint. A canvas hood is provided for covering these dials when not in use or when car is to be shipped.

An elevated platform with steps from the rear, and a ladder on each side of car immediately in front of frame are provided for handling those arms not accessible from the main platform. The car is well provided with protection by 1½-in. pipe railing around the main and elevated platforms, steps and rear end of car.

For the purpose of testing the accuracy of each arm a wooden testing frame is attached to sides at front end of caboose, with a saw cut in the outside edge to coincide with the center of each bolt in the head of measuring arm, which centers are the basis of all measurements and numbered with corresponding number. A string is placed in the saw cut and drawn over the center of the bolt. The arm is then set by dial and checked by actual measurement from the string to what would be the point of contact of arm. Several trials are made with each arm, setting at, say 6, 12 and 18-in. by dial and measuring each setting from string. A portable wooden extension is made for this frame to be applied only when testing arms, and may be used on either side of car.

CURVE MEASURING DEVICE.—A device for obtaining the degree of curve of track where obstructions exist, is attached to front of caboose and in center between trucks, extending through the floor to the rail. Provision is made for keeping it up from the rail and lowering when needed. This is made of a bar 2½ × ¼-in. iron, bolted below floor of car to a 2½-in. angle holding the rail rider, permitting the removal of lower part when shipping. The trucks are placed on 30 ft. centers so that the ordinate on curve for a chord of 30 ft. is obtained.

The rider on the rail and indicator point being the same distance from the bolt on which the bar pivots, the same movement is noted on the brass plate under indicator point as is made on the rail. This plate is graduated for lengths of ordinate obtained by the rider; but is marked in degrees so that the degree of curve can be read on the dial while car is in motion.

The rider is held against the rail by its weight, being set in one foot from a perpendicular line drawn through the pivot bolt, together with the sash weight attached to the upper part of the bar.

A standard caboose is set on the car and fitted with stove, lamps, stationary table, desk, chairs, lockers for tools and cushions for the observation seats.

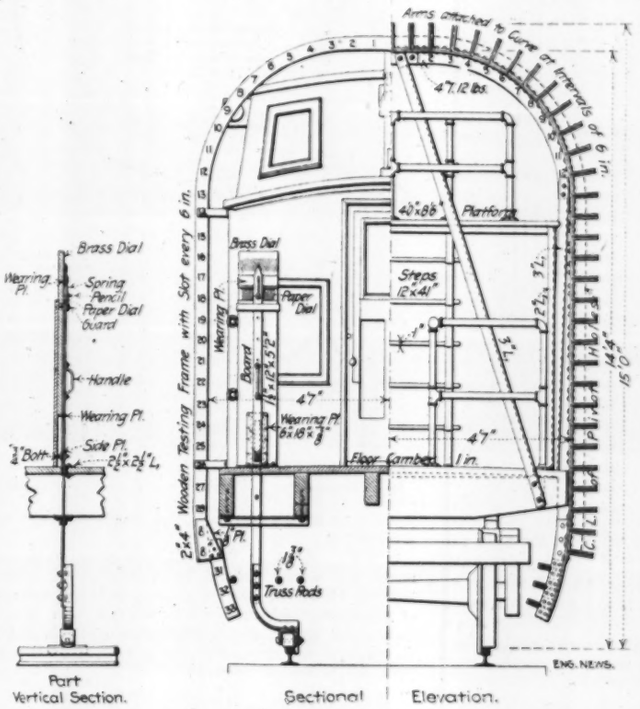


FIG. 3. SECTIONAL ELEVATION OF CLEARANCE MEASURING FRAME.

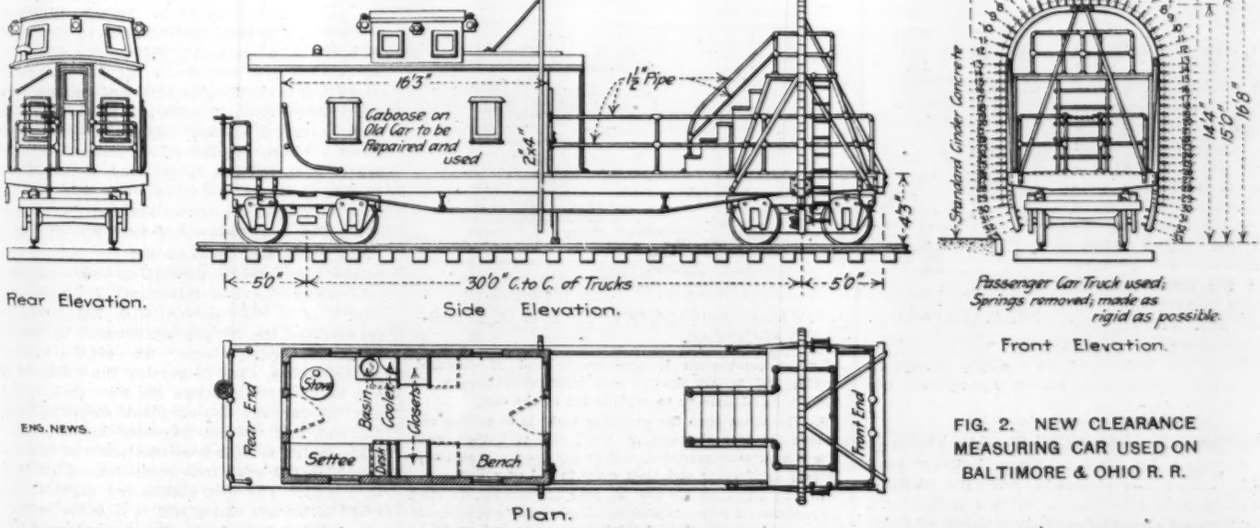


FIG. 2. NEW CLEARANCE MEASURING CAR USED ON BALTIMORE & OHIO R. R.

METHOD OF HANDLING CAR AND PREPARING CLEARANCE DIAGRAMS.

After completion, the car was carefully measured and a diagram on one inch scale drawn, using mounted paper as a protection against changes due to the weather. This diagram starts from a horizontal line across top of rail as a base, and follows the figure made by a line going completely around the frame through the center of bolts holding the measuring arms. Each arm is then laid off for its length of 24 ins., then lines are drawn one inch apart parallel to frame line, every three inches being indicated by heavy lines.

By laying a piece of tracing cloth over the template, readings taken on the car can be plotted direct. On the diagram all tracks are assumed to be level and clearance plotted accordingly. If on more than one track, the clearance is shown as single track, eliminating the distance between tracks, and each sheet marked showing whether single or double track. The line showing clearance on curve is marked with the degree of curvature.

All notes are taken and diagrams plotted on right and left facing the west, according to train charts.

The schedule for movement is prepared some time ahead and arrangements made for handling the car with private car attached for the operators, as a special train. Drafting work is done in the private car as the smoke and cinders from the engine made the caboose too dirty for this purpose. By having this car for the men, movement can be made at any time, either day or night.

The speed in going through tunnels, old bridges and rock cuts that are close, is about three or four miles per hour. On all tangents the readings are taken separate from those on curve, so that the ordinate can be applied for the latter, the rate of which is determined by the curve attachment previously described. In very rough country with many tunnels and bridges, 100 miles per day has been made, and 150 through country requiring average construction. This was on single track requiring use of both sides of car. For double track road, the outer side of one track is taken, returning on the second, or opposite track when around yards.

Platforms are the only obstructions not measured directly by the arms; the heights of these are obtained by using an oak rod, one inch square, graduated from the bottom up and measuring from a designated arm while the train is moving slowly. The distance from center-line is checked by having one lower and one upper arm graduated for every inch and lining the edge of platform with two marks on the graduated arms. On the clearance diagram, a line is drawn through the marks on arm and projected to meet the horizontal line on surface of platform as measured by rod.

For measuring clearances of overhead bridges outside of car limits a rod similar to rod for measuring platforms, but graduated from top down, rests in a hole through the elevated platform. Measurement is taken by raising the rod to meet the clearance line of bridge, and reading height from bolt in the head of arm zero.

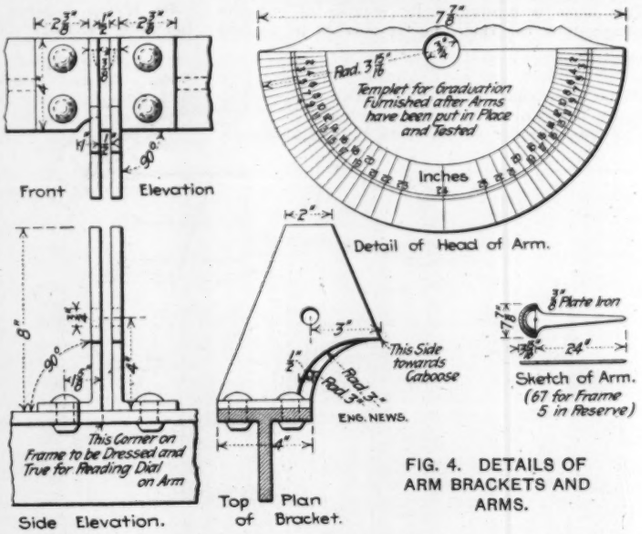

Front Elevation
Templet for Graduation Furnished after Arms have been put in Place and Tested
Inches
Detail of Head of Arm.
This Corner on Frame to be Dressed and True for Reading Dial on Arm
Side Elevation.
This Side towards Caboose
Rad. 3"
ENG. NEWS.
Top Plan of Bracket.
3/8" Plate Iron
Sketch of Arm.
(67 for Frame 5 in Reserve)

FIG. 4. DETAILS OF ARM BRACKETS AND ARMS.

An intelligent and careful engineman is a great help in this work; he must see that his fires are properly attended to, so that in entering a tunnel, the door to fire-box can be opened and remain so until the work is completed, by making all speed possible between obstructions, and slowing down at the proper time. By a little effort he can determine by eye, in a short while, the points that require attention. But when the whole train crew changes, at end of divisions, this factor cannot be relied on to expedite work.

In preparing clearance tables, an allowance of 6 ins. is made on each side for safe clearances and lateral movement of car-body, down to a point 4 ft. above top of rail. This is necessary, due to lateral movement of body on trucks, oscillation, low track joints, etc. Four ins. is allowed from this point down to top of rail.

Before the previous clearance car was run over the road, the track in all tunnels was resurfaced, and iron pins placed in the side walls as a guide for future resurfacing. The alinement was taken care of in the same manner by iron pins placed on center line. These precautions were necessary in tunnels that were close, as a slight change in tracks would, as a rule, materially reduce the clearance.

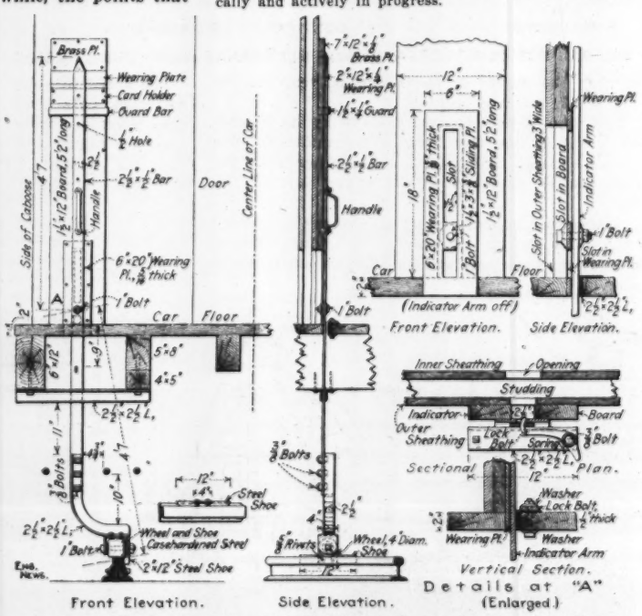


FIG. 5. DETAILS OF CURVE MEASURING DEVICE ON B. & O. CLEARANCE CAR.

SPONTANEOUS COMBUSTION IN COAL VEINS.

In a paper by Prof. Arthur Lakes,* read recently before the Colorado Scientific Society, the author calls attention to surface indications, in the western coal fields—mainly those of Colorado—of subterranean combustion in the veins. After citations from the Gunnison and Book Cliff regions of Western Colorado, and descriptions of the geological phenomena which are outgrowths of such underground fires, Mr. Lakes makes a resume of the matter as follows:

1. The spontaneous combustion of coal seams has taken place in several of our western Cretaceous coal fields.

2. This combustion is of chemical origin due to access of atmospheric oxygen to certain elements found in the coal, notably upon iron pyrites common to many seams.

3. Such combustion having commenced, various inflammable gases of the coal may have contributed to it and continued it.

4. Such combustion does not take place when coal seams are heavily covered by superincumbent strata, but only when their outcrops are exposed to the influence of atmospheric action, hence it occurred after canyon cutting and erosion of the coal-bearing plateaus, and is of comparatively recent date, being even at present locally and actively in progress.

5. The combustion is spontaneous and of chemical origin, and is not due to any mechanical agency, to surface forest fires or to exploitation of the coal.

6. The effect upon the overlying rocks is to oxidize and redden the iron elements in them; also to harden them into a quartzitic condition, and to change the shales to a jaspery consistency and their color to red or yellow.

7. The effect on the coal is, near the surface, to spoil its commercial value, to produce clinkers and graphite, and to cause the emanation of sulphurous gases and smoke to rise through cracks to the surface when the combustion is still active and in progress. At times, although the strata above are altered, the coal below may be little if at all changed.

8. Coal seams overlain by reddened altered rocks should not necessarily or invariably be condemned without some exploitation being done or analyses taken of the coal to prove it.

*Former Professor of Geology at the Colorado State School of Mines.

STEEL-FRAME 50-TON GONDOLA CARS: WABASH RAILWAY.

The Wabash Ry. has recently add to its equipment 2,000 high-capacity gondol ars for coal and general freight service, in wh a very substantial steel underframe is used, lle the sides, ends and floor are of timber. s con-sidered, however, that at present pric he use of steel siding would be economical. V are in-debted to Mr. J. B. Barnes, Superintend of the Locomotive and Car Department, for t ns and specifications of these cars. They wer uilt by the Western Steel Car & Foundry Co., o icago.

In Fig. 1 is shown the general design d con-struction, and it will be seen that the ncipal structural feature of the car is the sill nstruc-tion, there being four plate-girder sill 12 ins. deep at the ends and 25 ins. at the midd These give great rigidity under the heavy loa which are carried. The side sills extend the f length between end sills, but the center sills (5/8 ins. apart) are fitted between the bolsters; d ft sills extend from the bolsters to the end sills. All the longitudinal sills have 5-16 in. web pla es, and the top and bottom chords are each com osed of a single angle, 4x3 ins. The chords of the center sills are coped to fit snugly in the channels of the bolsters, to which they are secured with ½-in. angle plate connections. The chords of the side sills are secured to the end sills and bolsters by 5-16-in. gusset plates and angles. The draft sills are 12-in. channels, and each end sill is a 12-in. channel with an angle 5x3 ins. riveted to the top flange. At each end are two diagonal braces extending from the bolster to the corner of the frame, and it will be seen by the drawings that all these parts are fitted together with large gussets and connection plates. All rivets are ¾-in. and ⅝-in. diameter. At two points there are main cross ties or sway braces, consisting of top, bottom and diagonal members between the side and center sills; between the center sills this cross bracing is continued by a 5-in. channel at the top and a 3x3-in. angle at the bottom, all connected by gusset plates. There are six floor beams, each consisting of a 5-in. channel (in three parts), secured to the sills by 5-16 in. connection angles. The body bolsters are each composed of two 12-in. channels, extending between the side sills, with malleable iron spacing blocks or fillers in line with the center sills, and having top and bottom ¼-in. cover plates 27x46 ins.

Upon the floor beams are five lines of yellow-pine nailing stringers, secured to the supports by ⅝-in. bolts, the beams being so placed that the tops of the stringers are flush with the tops of the sills. The floor is of yellow pine planks, dressed to 2⅜ ins., and secured to the stringers with 5½-in. barbed wire nails. The side and corner stakes are seated on the bottom (outside) chord angles of the side sills, and secured beneath the floor by ¾-in. U-bolts passed through the top (inside) chord angles. Malleable iron clips are fitted between the bolts and stakes. The stakes are of oak, 4x5 ins. in section, so shaped on the outside that the width between side planks will be 1 in. less at the center than at the ends of the car. The end stakes are steel angles 3x4 ins.

The sides and ends of the car are of 10½-in. yellow pine planks, dressed on one side, and the side planks have a thickness of 2⅜ ins. Each length is in two pieces, with lap joints (staggered), and the planks are secured to the stakes by ½ in. carriage bolts. The planks are outside of the stakes, thus increasing the cubic capacity, but as this would make the side grab irons project too far, the second plank stops 24 ins. from the end, and the gap is closed by an inside steel plate which is bolted on the inside of the car and to which the grab iron is riveted. This is shown in Fig. 1. The end planks are sized to 2⅞ ins. and the bottom end plank is 13½ ins. wide. Corner bands of ¼ in. metal are secured to the planks by ½-in. carriage bolts.

The draft rigging includes the Miner tandem draft gear on 1,000 cars, and the McCord and the Farlow draft gears on 500 cars each. The M. C. B. couplers are of steel; and are of the Climax pattern with shank 5x7 ins. The end sills are cut to admit the couplers, while a malleable iron

strik[illegible] plate and a 5-16-in. coupler wearing piece [illegible] riveted to each of these sills. Push-pole [illegible]kets of malleable iron are placed at the corne[illegible] and side steps are riveted to the sills. The [illegible]stinghouse brake equipment is applied, havin[illegible] the cylinder secured to a 5-16-in. plate supported by a 5x3-in. angle riveted to the floor beams. For the hand brake, there is a 1⅜-in. brake shaft, with the usual wheel and pawl attachment, the pawl and ratchet being on an oak step 25 ins. below the top of the car. The train pipe is of 1¼-in. merchant pipe; the ⅜-in. retaining valve pipe has a Jefferson bronze joint union.

The principal dimensions and other features of these cars are noted below:

Length over end sills	41 ft.	5¾ ins.
Length inside	41 "	0 "
Width over side sills	8 "	7 "
Width over sides, at ends	9 "	9¾ "
Width over sides, at center	9 "	8¾ "
Height, floor to top of sides	4 "	5 "
Rail to top of sides	8 "	1¾ "
Rail to center of draft	2 "	10½ "

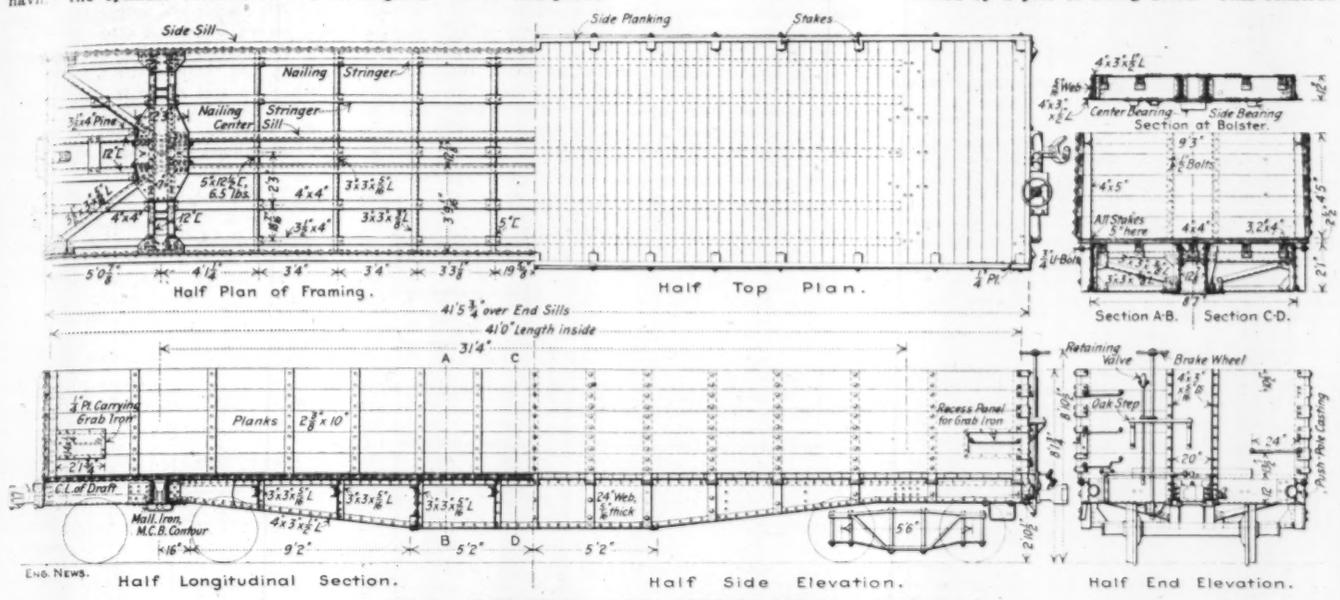


FIG. 1. STEEL FRAME 50-TON GONDOLA CAR; WABASH R. R.

J. B. Barnes, Superintendent of Locomotive and Car Department, Springfield, Ill.; Western Steel Car & Foundry Co., Chicago, Builders.

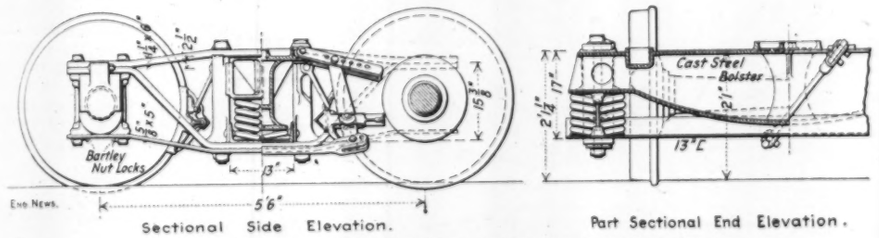


FIG. 2. ARCH-BAR TRUCK FOR 50-TON CARS; WABASH R. R.

The trucks are of the arch-bar or diamond type, as shown in Fig. 2, but with the upper arch-bar nearly horizontal (cambered only 2½ ins.) so that the frame departs from the actual diamond pattern as used on some roads. The vertical depth of the frame at the columns is 17 ins. The upper and lower arch bars are 1¼ × 6 ins., and the bottom tie-bar is ⅝ × 5 ins. The column castings are of malleable iron, and the spring plank is a 13-in. channel 7 ft. 5½ ins. long. The truck bolsters are of cast steel, of the Scullin-Gallagher Iron & Steel Co.'s make; these have the center and side bearings and the column guides all formed upon the casting. Under each end of the bolster is a nest of four springs of the M. C. B. class for cars of this capacity. The brakebeams are made of 5-in. steel I-beams, and the dead-lever guides are riveted to the bolsters. The axles are of open hearth steel, smooth forged between the wheel seats, and having journals 5½ × 10 ins. The journal-boxes are of the McCord malleable-iron pattern, fitted with Harrison dust-guards and having drop-forged steel wedges. The journal bearings are of the St. Louis spiral type. The wheels are of cast iron, 2 ft. 9 ins. diameter, and weighing 700 lbs. each. Every wheel is subjected to the thermal test.

All steel plates and shapes used in the construction of the cars and trucks are of open-hearth steel. Forgings are of steel, except that the grab-irons are of wrought iron. All castings are of malleable iron, except the brakeshoes, which are of grey iron. The cars are painted with the railway company's red mineral paint (three coats for all woodwork), and lettered in white-lead paint.

Wheelbase, truck	5 ft.	6 ins.
Wheelbase, total	36 "	10 "
Trucks, distance c. to c.	31 "	4 "
Wheels, diameter	2 "	9 "
Load capacity	100,000	lbs.
Cubic capacity	1,672	cu. ft.
Weight, empty (including trucks)	39,400	lbs.

DROP-BOTTOM CARS.—While the new steel-frame cars above described are all of the gondola type, with solid floors, the railway company had built last year a number of wooden cars of the drop-bottom type. The bottom opening is at the middle of the car, and is formed as a shallow hopper, with four compartments, each closed by a pair of swing doors. This construction is clearly shown in Fig. 3, prepared from drawings furnished us by Mr. Barnes.

These cars are 36 ft. long inside, and have six continuous longitudinal sills. The center and intermediate sills on each side are spaced far apart to give a wide opening for the hopper, while between them (at each end) is an intermediate sill extending from the end sill to a cross brace at the hopper opening. Each of the four openings is 5 ft. long and 2 ft. 2½ ins. wide. Draft sills are placed beneath the center sills, and behind these are sub-sills or fillers extending to the tie-beams or transoms which carry the truss-rod struts, and to which the doors are hinged. The side planking is inside the stakes, but the latter are cut at an angle at the top and have the top planks laid flaring in such a way as to give increased capacity with heaped-up loads. Inside vertical bolts have flattened strap ends which are spiked to the stakes.

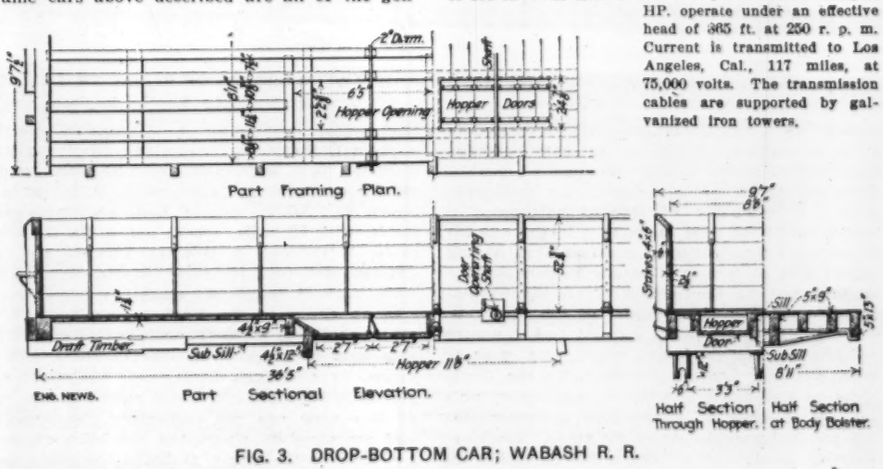


FIG. 3. DROP-BOTTOM CAR; WABASH R. R.

THE KERN RIVER POWER STATION NO. 1, of the Los Angeles Edison Electric Co., has recently been put in operation. It is located near the headwaters of the Kern River, in the Sierra Nevada Range. The plant is claimed by the builders to be the largest hydro-electric system west of Niagara Falls. The water is brought some twelve miles by flume to a penstock having a static head of 874 ft. Four Allis-Chalmers impulse wheels of 10,750 HP. operate under an effective head of 865 ft. at 250 r. p. m. Current is transmitted to Los Angeles, Cal., 117 miles, at 75,000 volts. The transmission cables are supported by galvanized iron towers.

AN ENGLISH RECTANGULAR ENGINE HOUSE WITH RADIAL TRACKS.

The design of engine houses has been a frequent subject of discussion among representatives of both the engineering and the motive-power departments of railway service, and the main points of discussion are in regard to the shape of the house and the arrangement of the tracks or stalls. The two typical designs are as follows: 1, a circular (or segmental) house with radial tracks served by a central turntable; 2, a rectangular house with tracks arranged longitudinally or transversely, and served either by a ladder track or a transfer table. The comparative merits of the two plans were discussed at some length in our issue of March 3, 1904. The advantages of the rectangular over the circular plan have been shown, but as yet the circular (or segmental) engine house, or roundhouse, continues to be generally used in this country, while in Europe the rectangular plan is preferred. The walls, and has four 65-ft. turntables, operated by electric motors. Each turntable serves 28 radial stalls, making a total capacity of 112 stalls (or 108 if allowance is made for the entrance tracks). The stalls are from 41 to 82 ft. in length, the shorter ones being used by tank engines, which form a considerable proportion of the equipment. The engine house is three miles west of the Paddington terminal station, and serves the London district, which has about 150 locomotives. Fig. 1 is a general plan, and Fig. 2 gives sections and elevations. This engine house may be compared with the following roundhouses of American railways, which are among

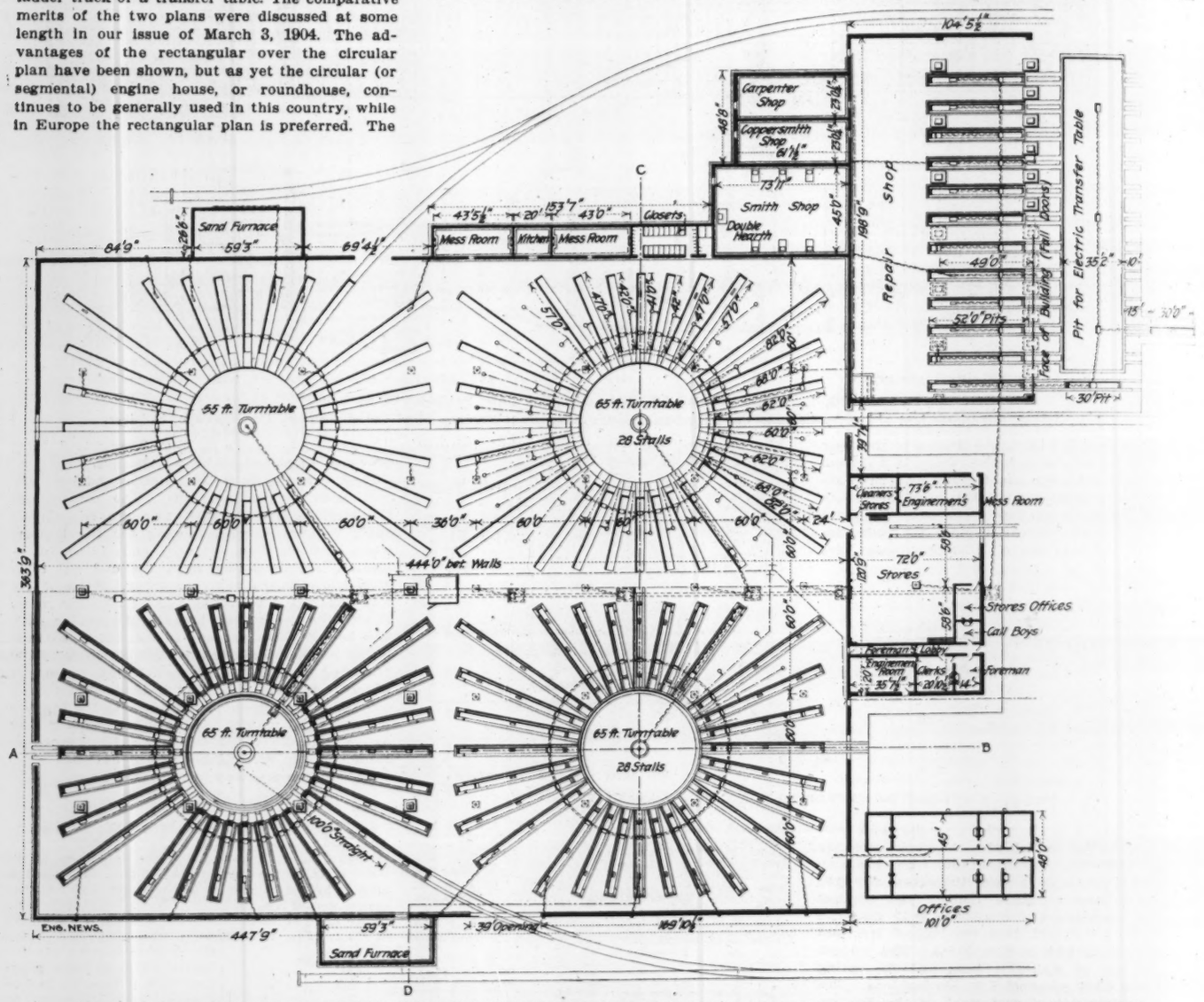


FIG. 1. PLAN OF RECTANGULAR ENGINE HOUSE WITH GROUPS OF RADIAL TRACKS AT SWINDON, ENGLAND; GREAT WESTERN RY.
G. J. Churchward, Locomotive Engineer.

capacity of a roundhouse, however, is limited to about 50 engines, so that two or more buildings are required where a larger number of locomotives has to be accommodated. In fact, even with the reliability of modern turntables, it would hardly be wise to make a larger number of engines dependent upon one turntable, having regard both to facility of service in handling the engines and to the possibility of the engines being imprisoned by a failure of the turntable.

We illustrate herewith the Old Oak Common rectangular engine house which has recently been built at London, England, by the Great Western Railway, and which is notable not only for the number of locomotives accommodated but for the arrangement of the stalls. The main building is rectangular 444 × 360 ft. inside the the largest ever built: 1, Chicago & Northwestern Railway, at Clinton, Ia., 375 ft. outside diameter, 82 ft. wide inside, with 50 radial tracks (48 for engines); 2, Pennsylvania R. R., at Altoona, Pa., 395 ft. outside diameter, 90 ft. wide inside, with 52 radial tracks and a 100-ft. turntable; 3, Chicago & Western Indiana Ry., at Chicago, 390 × 422 ft. (oval) outside, 89 to 95 ft. wide, with 54 tracks (51 stalls).

In an annex to the English roundhouse is a repair shop, 104 × 195 ft., with twelve pits 52 ft. long and 15 ft. c. to c. One of these pits is served by a through track, while the others are served by an electric transfer table. In the rear of this shop are the carpenters', blacksmiths' and coppersmiths' shops, the last being required for work on the copper fireboxes commonly used in English locomotives. A storehouse, [illegible] × 72 ft., and an office building, 45 × 90 ft., ar[illegible] on one side of the engine house, and there are t[illegible] sand-drying furnaces. Mess rooms and othe[illegible] accommodations are provided for the use of [illegible]e 250 enginemen and firemen in this distri[illegible] There are also about 250 machinists, helpers, [illegible] stage men, engine cleaners, boys, and other em[illegible]oyees. A foreman, with three assistants, has [illegible]ge of the engine house, and there is also a fo[illegible]an of the machinists. The coal stage is 104 [illegible]0 ft., and can accommodate six locomotives, [illegible]e on each side. The elevated water tank ha[illegible] a capacity of 290,000 gallons, and has a 15-[illegible] main

to the numerous hydrants in the engine house, and to five 8-in. water columns in the yard. All machinery is operated by electric power, which is distributed in two circuits—one for 600-volt direct current and the other for 220-volt three-phase alternating current.

The buildings have brick walls on concrete foundations, with cast iron or steel columns and steel girders for the interior framing. The pits have brick walls and concrete floors. The engine house is divided into 60-ft. spans in both directions, the cast-iron columns supporting longitudinal trusses upon which are carried the triangular roof trusses. The smoke jacks have enlarged rectangular hoods over the engine smokestacks and are 13 ft. 6 ins. clear above the rails. Each gable roof has a monitor with

skylight at the top and ventilating louvres in the sides; in addition to this, each slope of the roof has a skylight with louvres, as shown in the sections. The repair shop has two spans, the higher one being over the pits and having a 30-ton electric overhead traveling crane. The smaller span covers the machine and fitting shop. In this building, the columns are of steel, 30 ft. c. to c., while the pits are spaced 15 ft. c. to c. The track front of the building is formed entirely by swinging doors between the columns, and above these the whole front is of glass.

The Old Oak Common engine house replaces a rectangular building 650 × 70 ft., with four through tracks, which was built in 1852 (for tracks of 7-ft. gage), and also a later additional building, 135 × 180 ft. The new building was designed and built under the direction of Mr. G. J. Churchward, Locomotive Engineer of the Great Western Railway, who states that he finds the radial arrangement of tracks in groups the better for engine houses to accommodate 100 locomotives or more, but for smaller types the longitudinal arrangement is preferred.

A SUGGESTED DEVELOPMENT IN RAILWAY TRACK.*

By J. W. SCHAUB, M. Am. Soc. C. E.†

No one who has noticed the approach of a heavy train by keeping his eyes near the track, can have failed to notice the extraordinary wave in the track which is formed in front of the engine. This wave appears to be about twice its actual height, as it is formed not only by depressing the track immediately under the engine, but the track immediately in front is actually lifted, thereby forming a true wave motion. If the train is moving at a high rate of speed the observer will be impressed by the lack of rigidity of the whole structure. The cause of this wave motion is the yielding of the track. The dynamic action of the moving load must be absorbed by the rails, the ties, and the substructure underneath. This tends to push the entire track in front of the wave and this yielding of the track accounts largely for the creeping of the rails. If the ballast is hard and frozen, as well as the substructure underneath, the rails must absorb the bulk of this energy. If these conditions are such as to produce an uneven hardness (such as a sudden frost in earth full of moisture) combined perhaps with a low joint, the chances are that a broken rail will result.

Steel is brittle, as a rule, owing to the presence of phosphorus; but the rail manufacturer says that phosphorus has been gradually eliminated, until now it is at least 25% less than it was 15 or 20 years ago. But what of the carbon? In the last few years the requirements for carbon have been increased by over 100%. Is it safe to make a high carbon steel, carrying 0.60% of carbon in the presence of 0.10% of phosphorus? In other words, has the phosphorus been eliminated sufficiently to compensate for the increase in carbon? The railways should insist upon a reasonable limit for phosphorus and make the rail manufacturers live up to it. Just now it would be interesting to know why the railways have to accept the manufacturers' standard.

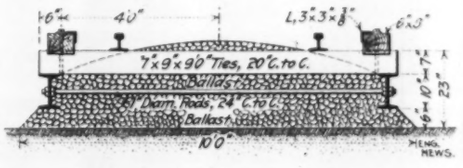
*Abstract of a paper read before the Western Society of Engineers, Chicago, May 29, 1907.

†Consulting Engineer, Monadnock Block, Chicago.

No concerted effort has been made to analyze this problem, other than to blame the rail manufacturer for the poor quality of the rails, but there is another side to this question that has not received proper consideration. Quoting from the excellent paper on track superstructure by Mr. O. E. Selby:*

> Railway track has grown in strength as heavier loads have made increased strength necessary, but such growth has been entirely along empirical lines, and not one single detail of track superstructure bears marks of engineering design.

Given a line of rails which have to carry moving loads reaching 20,000 or 30,000 lbs. and more per wheel, the loads which they carry must be distributed over large areas. The cross-tie system accomplishes this by inserting 16 to 20 independent supports under each 30 ft. of rail, and upon the track department is placed the impossible task of so adjusting these supports that each shall bear an equal part of the load. This is the real secret of the enormous amount of labor spent on surfacing a track in order to carry trains at high speed, and it is a work that goes on forever. Moreover, assuming a joint has not been kept up to surface, what happens when a wheel passes over it? Within certain limits the ends of the rail will deflect until the tie receives a firm



A Suggested Form of Railway Track Construction.
J. W. Schaub, M. Am. Soc. C. E., Designer.

bearing; and, all track shows, more or less, the effect of the lack of continuity in the rail by the dip of the rail at every joint.

Mr. Gustav Lindenthal, M. Am. Soc. C. E., has designed a form of steel longitudinal support for the rails, having rock ballast under the longitudinals, covered by a sand or gravel filling. Think of putting down a bed of clean rock for ballast, and then covering it with sand, as though the difficulty in keeping the ballast clean is not enough without mixing it with sand. There will be a prism of broken stone supporting the steel girder, and, when, with a good deal of labor this broken stone is packed into just the right shape, why not put something into it that will keep it there, instead of having it jarred out of place by the traffic. This form of track is being tried experimentally by the Pennsylvania R. R.† on the Philadelphia Division, and the experience with it is exactly as should be expected. It is impossible to keep such a track in surface. The tendency of the prisms under the rails is to flatten out, and this is exactly what takes place. The system of longitudinal support will never prevail unless combined with some transverse support.

The plan suggested by the writer is to take the present type of track, with ties sawed to size and surfaced on one side to uniform thickness, laid on rock ballast at leas 16 ins. deep. Steel I-beams are placed temporarily under the ends of the ties, so that each tie will have a full bearing on the beam at each end as shown in the accompanying cut. The beams are to be of the special type with broad flanges to be rolled by the Bethlehem Steel Co. The beams are to be tied together by tie rods 2 ft. c. to c., so as to confine the ballast between the beams. On the ends of the ties previously is laid a bond timber notched over the ties at least 1-in. and held down by hook bolts passing through the tie, and anchored to the inside flanges of the beams. An angle iron nosing on the inside of the bond timber serves as a guard rail. After all is in place, the extraneous ballast, that outside of the beams, is removed. No part of this operation need interfere with the movement of traffic over the road.

In bringing such a track to surface, the entire structure is to be lifted by means of track jacks placed under the flanges of the beams. After the ballast is once in place, very little work should be necessary to keep such a track in surface. The ballast is confined between the beams, so that an arch action can take place, with the thrust of the arch taken up by the tie-rods. This assumption makes it possible to find the tension on the rods and properly proportion them.

This form of track offers advantages over the present form of track, solely in the introduction of the longitudinal beams, which are to perform two distinct functions: 1, the special beam, with a moment of inertia equal to five times that of an 80-lb. rail, should do just five times the work done by the rail when both are working together under the same conditions, neglecting the work done between the cross-ties in either case. The work done by the rail would then be principally to distribute the load over the ties, and not to make up for the deficiencies in the substructure, as it does now. 2. It will confine the ballast, and thereby prevent the track structure from working its way down through the ballast as it does now in the present form of track. Under heavy traffic the ballast is kept in constant motion during the passage of trains, and as the particles of the granular mass are free to move, they follow the line of least resistance, that is out from under the ties. This explains why the ballast is so unstable, and accounts for the enormous amount of labor necessary to keep a track in surface and alinement. With the proposed form of track, on a solid substructure, this should largely disappear.

After this form of track has been proved by experiment to be correctly designed, the timber should be removed, and the ballast replaced by concrete flush with the tops of the beams, forming a permanent substructure upon which the superstructure is to be placed. At the same time the steel beams can be removed. This superstructure should be some form of longitudinal support bedded in concrete, so as to distribute the loads over large areas, offer perfect drainage and be absolutely imperishable and unyielding.

*Engineering News, Feb. 14, 1906.

†This track was described and illustrated in Engineering News, Nov. 30, 1905. Instead of steel chairs being laid on the longitudinals to carry the rails, wooden blocks are used, very much as in the track of the Philadelphia rapid-transit subway. Engineering News, Aug. 2, 1906.

THE NEW STATE EDUCATIONAL BUILDING at Albany, N. Y., will, it is said, have the longest and highest Corinthian colonnade ever built. There will be 28 Corinthian columns, each 65 ft. high, set in a line extending over 500 ft. from east to west along the north side of Washington Avenue, facing the capitol.

The building will be 600 ft. long and four stories high; the estimated cost is over $4,000,000. The Education Department administrative offices will be on the first floor. The state library, with a capacity of upward of three million volumes, will have the second and third floors. The library delivery room is to be one of the most imposing features in the new building. It is to be in the center of the structure. The state museum will be on the fourth floor.

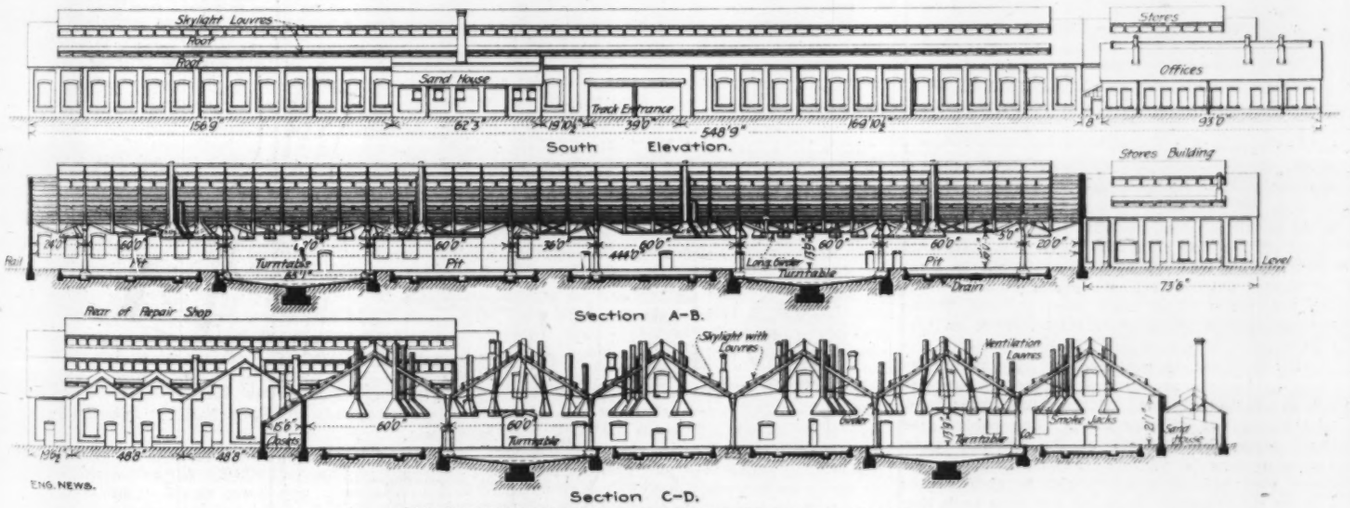


FIG. 2. SECTIONS AND ELEVATIONS OF ENGINE HOUSE.

AN 80-FT. FLAT CAR TRUSSED WITH STEEL CABLES.

The use of very long rails has become so common on European railways that the Belgian lines of the Northern Ry. of France frequently have to carry rails as long as 78.72 ft., rolled at the great steel works in the Liege district. These are usually carried on a number of ordinary flat cars coupled together, but for greater convenience it was decided to build specially long flat cars. They were designed under the direction of Mr. Du Bousquet, Chief Engineer of Motive Power and Equipment, to meet the following requirements: 1, To carry 40 tons of rails of 50 to 78.72 ft. in length; 2, To keep within clearance limits on curves and reverse curves of 720 ft. radius, and to pass freely around curves of 295 ft. radius in the yards at the steel works.

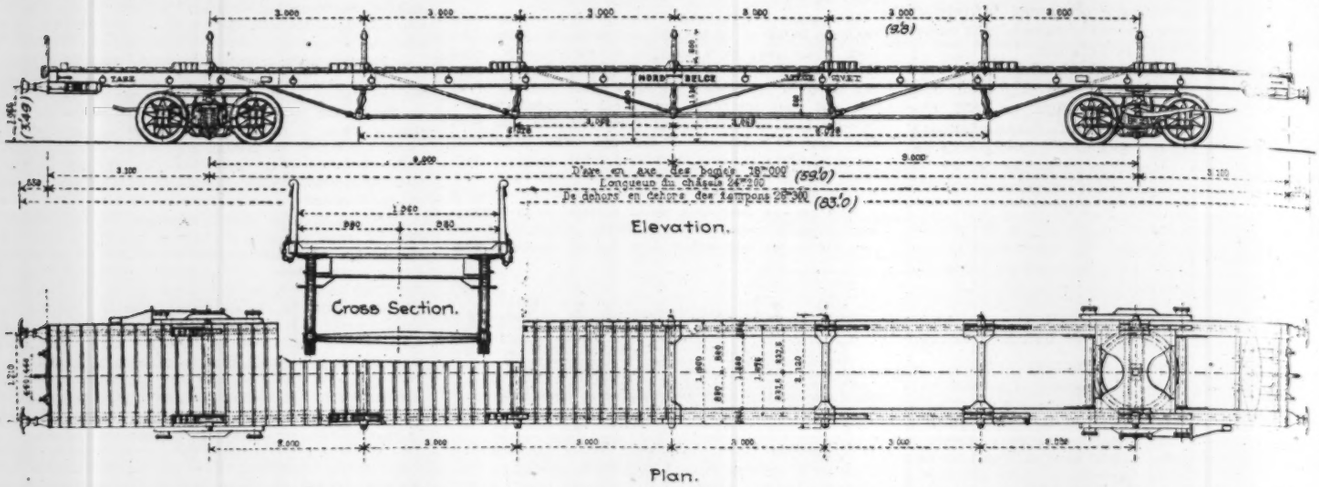


FIG. 1. 80-FT. FLAT CAR FOR RAILS WITH TRUSS CABLES AND TURNTABLE TRUCKS; NORTHERN RAILWAY OF FRANCE (BELGIAN LINES).

The car is 83 ft. long over the buffers, and 79.37 ft. over the floor, and is supported on a pair of four-wheel trucks 59 ft. c. to c. Owing to the requirements as to clearance, the width is reduced to 6.43 ft. between side stakes and 6.95 ft. over all. In order to combine strength with a minimum of dead weight, the frame is composed of two side sills 6.15 ft. c. to c. connected by transoms 9.84 ft. apart. Each sill is composed of a pair of channels, placed back to back, 3½ ins. apart, with cast steel spacing blocks between and a cover plate 0.4-in. thick on top. The floor is of transverse planks. Between the trucks each sill is supported at five points by trussing, but the most novel feature is that wire cables are used instead of the usual truss rods. The struts are of cast steel. The cables give three times the strength of the ordinary rods, and can thus be made of smaller section; the consequent reduction in weight is about three tons in the trussing alone, or five tons including the saving in the attachments, etc. The arrangement is shown in Fig. 1.

There are three cables to each sill. The first is 1.6 ins. diameter; this is anchored over the trucks and supports the outer struts; the next is 1.4 ins. diameter, while the third and shortest is 0.8-in. diameter. The style of end attachment is shown in Fig. 2. The cable being cut to length, its ends are strongly wrapped and then each end is inserted in a sleeve, A, the end of the hole in which is slightly conical. The cable is drawn through 6 or 8 ins., and unwrapped; the ends of the wires are then separated and bent back upon themselves, and the enlarged end of the cable is then forced back into the conical part of the hole. The sleeve is then placd vertically, and when heated the opening B is filled with a white metal composition (84% tin, 11% antimony, 5% copper). It is, of course, necessary to provide for tightening up and adjusting the cable. The end D, E of the sleeve is square, but the part D, C is cylindrical and threaded. Over this is a long sleeve nut or cap nut bearing against a lug on the sill, and by turning this nut the cable can be adjusted as desired, the square end of the sleeve preventing the latter from revolving with the nut.

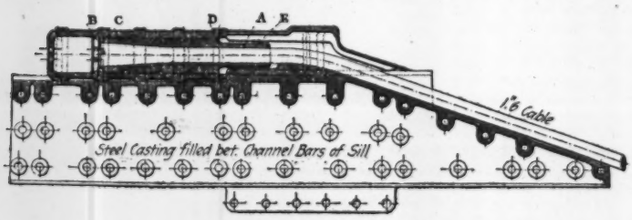


FIG. 2. ANCHOR AT END OF TRUSS CABLE.

The cast steel struts have pin bearings at each end, the lower end being attached to a saddle which rests upon the cable, and the upper end to one of the spacing blocks of the sill. The saddle is held in position by blocks or lugs clamped upon the cable as shown in Fig. 3. The faces of these lugs are curved to allow of the movement of the strut. The struts are connected by cross pieces in order to keep the cables in line with the sills.

Another interesting feature is in the trucks, which have turntable bearings and four conical rollers, instead of the usual center plate and side bearings, as shown in Fig. 4. The diameter of the turntable is 5 ft. The truck frames are of the arch-bar pattern, and the bolsters have four heavy coiled springs at each end. The truck wheelbase is 6 ft., and the axles have journals 5.2 ins. diameter and 10.2 ins. long. Each truck has a hand brake with a horizontal lever operating the four brakeshoes, this, of course, being available only in switching. Owing to the narrow spacing of the sills they necessarily set high to clear the wheels, and the buffers and draft rigging are therefore placed beneath the sills. The weight of the car is about 24.75 tons. Our description and illustrations are taken from an article in the February number of the "Revue Generale des Chemins de Fer," by Mr. M. M. Lambert, Engineer of Rolling Stock of the Belgian Lines of the Northern Ry. of France.

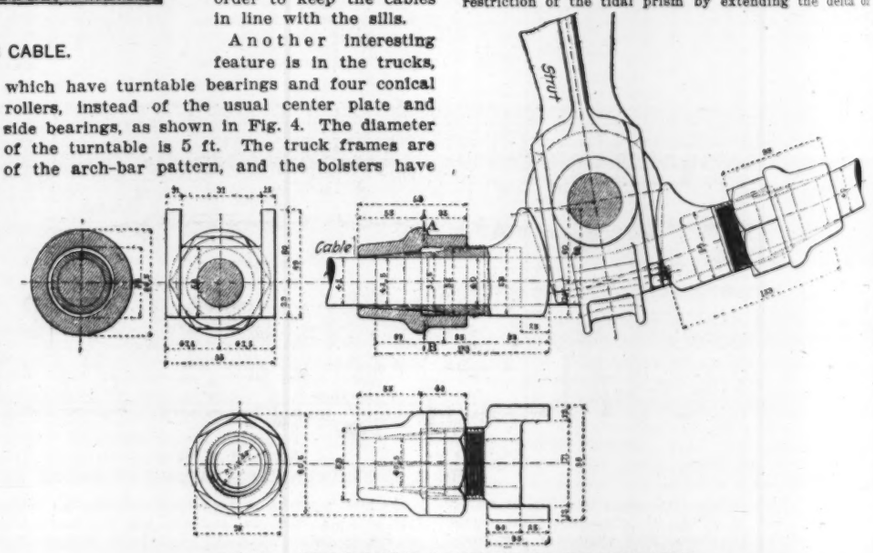


FIG. 3. ATTACHMENT OF STRUT TO TRUSS CABLE.

A 66-ft. flat car of wooden construction, specially designed and built by the Cleveland, Lorain & Wheeling Ry. for carrying rails, was described and illustrated in Engineering News of May 9, 1901.

MINING DEBRIS IN CALIFORNIA RIVERS is being investigated by Mr. E. C. Murphy, of the U. S. Geological Survey, in conjunction with Mr. G. K. Gilbert. Some of the work is being carried on in a laboratory in the Mining Building of the University of California, through the courtesy of the University authorities. According to an article published in a recent issue of the Sacramento "Bee," Mr. Gilbert has offered to contribute to the expense of continuing investigation, the scope of which he outlines as follows:

I have undertaken (1) to inquire how far the flood conditions are due to other causes than the overloading of the rivers with detritus, (2) to inquire how far the overload of the rivers is derived from other sources than hydraulic mining, (3) to make an estimate of the quantity of mining debris that has been excavated, (4) to study the effect on the harbor (of San Francisco) of the restriction of the tidal prism by extending the delta of the Sacramento, (5) to investigate the laws of transportation of detritus by running water, and (6) I have tried to secure an investigation of the agricultural quality of river deposits composed largely of mining debris.

Mr. Murphy has been making experiments in the laboratory already named, designed to throw light on the transportation of mining debris by water.

MOTOR CARS FOR OPERATING INTERURBAN RAILWAYS.

The use of motor cars in railway service has been considered mainly in connection with branch lines or local main-line service on steam railways. But such cars appear to be specially applicable to certain classes of the interurban railways which are now being built so extensively. The majority of these railways are operated on the overhead trolley system, but where the traffic is light and requires only a comparatively infrequent service, as in cases where the line serves small towns or where it opens up a district of its own, and is not competitive with a steam road, the service might often be furnished by independent motor cars. This would avoid the initial expense of a power station and line equipment, as well as the expense of operation and maintenance of this plant, while at the same time it would be more economical and satisfactory than a service of steam trains. The application of this system of traction has been limited, but there certainly appears to be a field for its use, and we give below particulars of two lines operated in this manner.

ST. JOSEPH VALLEY TRACTION CO.—This road extends from La Grange to Middlebury, Ind., a distance of about 20 miles, and does not parallel or compete with any existing road. Extensions are under construction. It was operated for nearly two years by a gasoline-electric motor car, but this was destroyed about two months ago in a fire which burned down the building where the car was housed. Since then the road has been operated by a steam locomotive. The reason for adopting the motor-car system of traction was that the district served does not require a frequent service of cars, and therefore the first cost of a power-plant and line equipment for a trolley line could well be dispensed with. The road has maximum grades of 1% in the country and 1½% in the streets of towns. The sharpest curves are of 10% in the country and 75-ft. radius in streets. The track is laid with 70-lb. tee rails on ties 6 × 8 ins., 8 ft. long; there are 16 ties to a rail length of 30 ft. Mr. M. L. Swinehart is Chief Engineer and Superintendent.

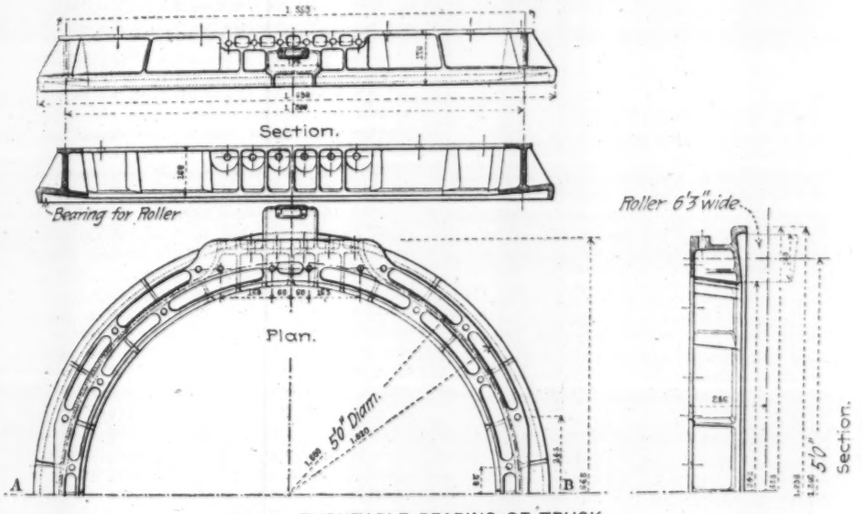


FIG. 4. TURNTABLE BEARING OF TRUCK.

The regular train equipment consisted of a gasoline-electric motor car (80,000 lbs.) and one trail car (20,000 lbs.) These were run together, as the motor car had only an engine room and baggage compartment, with no accommodation for passengers. The schedule was one hour for the run of 20 miles, with an average of ten stops. The maximum speed was 35 miles per hour. Three round trips were made daily, or 120 miles per day, and the cost of operation is given as 15 cts. per car-mile, including labor and gasoline. The consumption of gasoline was about 0.6-gallon per car-mile; this included all stops, running to and from the car house, and an occasional run to give the batteries an over-charge. Without the trail car the consumption would of course have been considerably lower, and motor passenger cars noted further on are reported to have an average consumption of 0.45-gallon per car-mile.

The motor car was designed by Mr. Herbert E. Bucklen, president of the company, and was built by the Hicks Locomotive & Car Works, of Chicago. It was 34 ft. long and 9 ft. 8 ins. wide, divided into two compartments. The engine compartment occupied about two-thirds of the length; the other compartment was for baggage and freight, but contained also some of the storage-battery cells and the motor-compressor unit for the National air-brake system. The car could be operated from either end. For the underframing, there were two 6-in. I-beam center sills; with two side sills and four intermediate sills of timbers 5 × 8 ins. and 4 × 6½ ins., respectively. The end sills were of oak, 8 × 12 ins., and there were also timber transoms. The underframe was stiffened by two 1½-in. truss rods.

The engine was a four-cylinder, marine-type, vertical gasoline engine of 70 HP., built by the Marinette Gas Engine Co., of Chicago Heights, Ill. It was placed with its shaft lengthwise of the car and directly connected to a Sprague 50 KW., 250-volt, direct-current generator. The cooling water for the cylinder jackets was circulated by a rotary pump belted to the engine shaft, and the water passing from the jackets was cooled by circulating it through coils of about 800 ft. of ¾-in. ribbed radiator pipe; this piping was placed close to the roof, and a current of air forced over it by two 42-in. horizontal fans. The generator furnished current for four motors of 35 HP., but for the heavy work of starting and accelerating the car it was assisted by a storage battery of 120 chloride cells. The generator also supplied current for lighting, for the battery on the ignition apparatus of the engine, and for the 4 HP. motor of the air-brake compressor unit. To start the engine the generator was driven as a motor by current from the storage battery until the engine was working normally with gasoline. It could also be started by air compressed to 200 lbs. pressure in two cylindrical tanks by means of a compressor belted to the engine. The brakes could be operated by air from these tanks if necessary, a reducing-valve limiting the pressure to 90 lbs. for this service. The car had a tank for 125 gallons of gasoline, and another for 190 gallons of water. The distribution of weight of this motor car was about as follows:

	Lbs.
Body and trucks	33,600
Gas engine	18,000
Generator	6,000
Storage battery	9,000
Motor equipment	10,000
Gasoline	2,000
Water	2,000
Miscellaneous	4,000
Total Weight	84,600

MISSOURI & KANSAS INTERURBAN RY.—This road is 22 miles in length, extending from Kansas City, Mo., to Olathe, Kan. It is operated by three gasoline-electric cars of the Strang type, which have a power system very similar to that of the car above described; they are, however, passenger cars, and haul trail cars only during periods of heavy traffic. In the Strang system, an engine with inclined cylinders on opposite sides of the shaft is placed lengthwise of the car and directly connected to a generator, from which the current passes to a controller and thence to the four motors. When the car is drifting, however, the surplus current generated goes to charge a storage battery which in turn supplies the extra power required in starting and accelerating the car, or in ascending heavy grades. This system was described and illustrated in our issue of March 8, 1906, and is owned by the Strang Gas-Electric Car Co., of 15 Wall St., New York. The cars and trucks are built by the J. G. Brill Co., of Philadelphia, Pa.

The first car made the trip from Philadelphia to Kansas City under its own power in March, 1906, and was exhibited at various places on the way. Its speed was from 33 to 45 miles per hour. It has made trips on a number of roads, including the Burlington branch of the Atchison, Topeka & Santa Fe Ry.; this branch has 3% grades and 16° curves, but the car was able to stop and start on the heavy grades. It was then used to haul construction trains on the interurban line. It was put in regular service early in April, 1906, and runs about 220 miles daily. This car is said to have traveled about 60,000 miles, with an average consumption of 0.45-gallon of gasoline per mile, and without any repairs to the power equipment. The second car made the trip from Philadelphia in August, 1906; and for the run between Cumberland, Md., and Chicago (nearly 700 miles), the engine was not stopped, while the car only made the stops necessary for train orders. For the entire trip of 1,310 miles, the average speed was 30.7 miles per hour, with a maximum of 60 miles per hour. The consumption of gasoline was 0.46-gallon per mile; average voltage, 243 volts; average current generated, 180 amperes; average current consumed by motor, 165 amperes. The third car was assembled at the railway company's shops at Lenexa, Kan.

These cars weigh about 40 tons each; the second and largest is 52 ft. 8 ins. long and seats 50 persons in the main and smoking compartments. The company states that several cars 63 ft. long are being built for use in local and branch line service on the Chicago & Alton Ry. and other steam roads. These are of steel frame construction, with power equipment sufficient for speeds of 50 to 60 miles per hour. Cars of this character are also claimed to be especially adapted for use as inspection or officers' cars on steam railways, as they can be operated without being dependent upon locomotives or train service.

GOOD ROADS IN CUBA are a crying necessity which the Provisional Government is trying to supply at all possible speed. The last Cuban Congress appropriated $5,500,000 for building highways and bridges throughout the island and this money is being expended on 230 different contracts ranging in size from $1,000 to $100,000. The present plan of road development calls for an expenditure of $13,000,000, the work to be finished within three years. The means of internal communication in Cuba are in such deplorable condition that any interstate trading is practically impossible and a well ordered campaign to provide passable highways is one of the principal steps toward the commercial betterment of the island.

MONAZITE, the mineral from which are derived the materials employed in making incandescent gas mantles—cerium, lanthanum, didymium and thorium—is practically all obtained in North and South Carolina. The entire output of the crude sand for 1906—approximately 2,000,000 lbs.—came from the Carolinas. Local mills cleaned the sand, which varied greatly as to grade, up to a grade of 80% or more of monazite; on a basis of 80% the total monazite output for 1906 was 846,175 lbs., valued at $152,312.

A NEW LOCK-BAR STEEL PIPE.

By MAX KRONAUER, C. E.*

The friction of water flowing in a riveted pipe due to the projecting rivet heads is well known to engineers. The effect of this friction is to reduce to a very material extent the capacity of the pipe; and in order to deliver a given quantity of water a pipe must be made much larger than would be necessary if its interior surface were smooth.

Whenever a section of riveted conduit is uncovered, after several years' service, more or less sweating or leaking at the riveted joints is noticeable. Such leakage induces corrosion of the steel along joints and rivets, as the contact surfaces of overlapping plates are not protected by the pipe-coating. As the pipes are tested in the shop under hydrostatic pressure exceeding the subsequent working pressure, and all joints are made perfectly tight before the pipes leave the works, this leaking of pipes in the trench proves that transportation and rough handling of riveted pipe causes material injury to the seams.

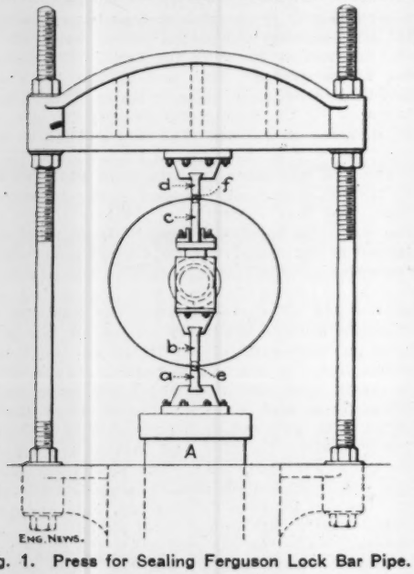


Fig. 1. Press for Sealing Ferguson Lock Bar Pipe.

The above objections to riveted pipe could be avoided by welding plates, instead of riveting. The high cost of the different welding processes, however, forbids their use for the manufacture of large diameter plate pipe.

This has led to the invention of "lock-bar" pipes, in which the adjoining edges of the plates are inserted into grooves formed in steel bars, and are therein securely clamped by compression of the outer edges of the bars.

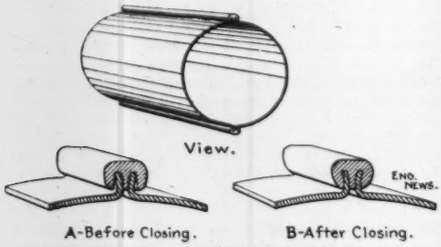


Fig. 2. The Kronauer Patented Lock Bar Pipe.

The first use of lock-bar pipe on a considerable scale was for the 300-mile pipe line to Coolgardie, West Australia, where the lock-bar pipe invented by Mephan Ferguson was used.†

Numerous mechanical difficulties are, however, encountered in the manufacture of the Ferguson pipe. The closing of both bars was done in the machine shown in Fig. 1. It is accomplished by one upward thrust of the ram (A). It is evident that the center-lines of the dies (a, b, c d) and the center-lines of the bars (e, f) must lie in one vertical plane, and that any deviation from such alinement will cause "biting" or twisting of the bars by the dies. The adjustment of the two middle dies (b, c) is especially difficult for the reason that they are fastened to the suspended end of a mandrel of 32 ft. reach.

Variations in thickness of the plate, as well as uneven hardness of the steel—conditions which cannot be avoided—cause irregular upsetting, and the plate-edges are also more or less bent or "kinked" during the process of crimping. Such irregularities cause twisting of the bars, when the plate-edges are forced into the grooves by circular assembling clips.

It has also been found that great care must be taken in selecting the steel for the Ferguson bars. The increased thickness of the upset plate edges necessitates wide opening of the jaws or flanges of the bars, and it is evident that the stress produced by compressing forces must be greatest through the web of the lock bar, and also increases with the width of opening. If the steel is mild and ductile, distortion takes place, and the metal follows substantially the form of the dies; but if the steel is hard and brittle it will yield to tension, and rupture takes place at the base of the leg.

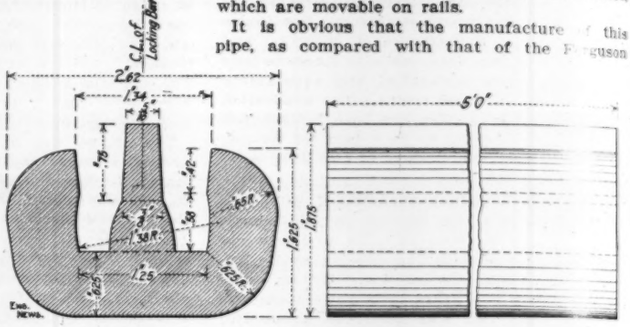


FIG. 3. SECTION AND ELEVATION OF KRONAUER LOCK BAR FOR 30-IN. PIPE SECTIONS; TESTED BY BETHLEHEM STEEL COMPANY.

THE KRONAUER LOCK-BAR PIPE.

In designing this new pipe, which is illustrated by Figs. 2, 3 and 4, it was the writer's chief object to provide a lock-bar pipe which would possess all the desirable features of the Ferguson pipe, while requiring less cumbrous machinery and offering fewer difficulties in closing the seams.

It was obvious that a modification in the forming of the plate-edges and disposition of the bars out of the plate circle would not only simplify the construction, but would also afford a joint of greater reliability as to its strength, unimpaired by possible carelessness on the part of the shop mechanic.

It will be noticed from Fig. 2 that the bars of this pipe have parallel grooves lying in a direction radial to the plate curvature (while the grooves in the Ferguson bar lie directly in the line of curvature). The plate edges are bent out radially so as to form longitudinal flanges, and the bars are wholly outside of the pipe. The closing of the bars, therefore, requires no mandrel or other apparatus bearing on the inside, and a simple press can be used, whose thrust is in a direction tangential to the pipe curvature.

The fin, which separates the two grooves formed in this lock bar, is widest at its base, and its width decreases along curved lines to a certain height, from where it follows slightly converging straight lines to its extreme end. This is shown in Fig. 3, which is a cross-section of a bar for 30-in. pipe, made and tested at the plant of the Bethlehem Steel Co.

In assembling, the flanged portions of the plates are inserted into the grooves of the bars, as shown by Fig. 2 A, and when the bars are compressed the joints assume the form illustrated by Fig. 2 B.

Frictional resistance of the contact-surfaces and a bend in the plate-portions which are firmly embedded in the body of a steel bar, constitute thus the elements of strength and stability of this pipe seam.

The forming of this pipe requires:

(1) Shearing of plates.
(2) Bending and flanging of plates.
(3) Assembling of plates and bars.
(4) Closing of bars by compression.

For the bending and flanging operation a hydraulic press has been designed, which will bend the plate to semi-circular shape and also flange out its longitudinal edge-portions by compression between male and female dies. This press is operated by two equal and simultaneously acting rams of a combined maximum power of 700 tons.

The shaped plates and the bars are assembled and held together by circular clips, and this tubular body, or pipe with open seam, passes on trucks, which are arranged and driven like a spacing-table between two presses, whose dies close the bars simultaneously. (See Fig. 4.) The position of the dies is adjusted for different sizes of pipe by shifting of the closing presses, which are movable on rails.

It is obvious that the manufacture of this pipe, as compared with that of the Ferguson pipe, is less complicated and less laborious. The forming or shaping of the plate after shearing is accomplished by one operation only and with one machine, and the closing of the bars placed outside of the pipe-shell offers no difficulties. Greater stability of tubular assemblage, previous to closing, is effected by bearing of circular clips on bars, as well as on plates, and the danger of rupture of bar is avoided by modified deflections.

While the Ferguson pipe has a stiff joint, the plate flanges of this pipe allow expansion of shell and reduce the intensity of such shocks.

As the machinery necessary for closing the seams of this pipe is portable and of simple construction, it may be installed along the route of the conduit, and the shaped and curved plates and the bars shipped loose from the works can be assembled and closed on the ground. No other type of pipe offers this advantage, which is, of course, of greatest importance in case of export, poor transportation facilities or excessive cost of inland freight for large diameter pipe.

It may be thought that this pipe would be unsuitable for high pressures since the circumferential stress due to internal pressure would tend to open the locking bar. To settle this matter by direct experiment, tests were undertaken at the works of the Bethlehem Steel Co. at the instance of Mr. Thos. H. Milson, formerly of the East Jersey Pipe Co.

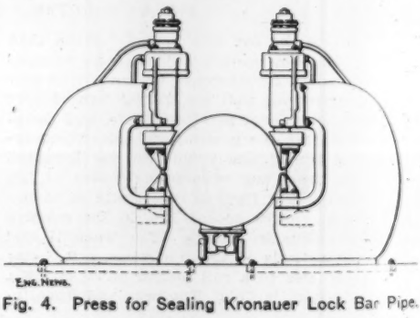


Fig. 4. Press for Sealing Kronauer Lock Bar Pipe.

The bar shown in Fig. 3 was fitted on a section of 30-in. pipe 5 ft. long. The tensile strength of the steel was not known or computed, but the highest internal pressure recorded on the test gage was 1,800 lbs. per sq. in. As this was the heaviest recorded pressure for plate seams, it was not deemed necessary to make further tests.

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†See Eng. News, Feb. 10, 1898, for a description of the Ferguson scheme and a profile of the pipe line; Feb. 17, and Oct. 13, 1898, for current editorial discussions of the pipe line, including recommendations of the English engineers; Dec. 29, 1898, for costs; June 29, 1899, for additional developments.

THE APPLICATION OF ELECTRICITY TO REVERSING ROLLING-MILLS OF HIGH POWER.*

By D. SELBY BIGGE.†

Increased confidence in the power of electricity as an absolute solution to many engineering difficulties is one of the main stepping-stones to progress, and has been a distinct encouragement to inventive genius.

Few industries have provided a greater scope for new applications of electric-power than the iron and steel trades, and it will be the author's endeavor in the course of this paper to deal with some matters of latest interest to those engaged in these trades.

Although great economies have been effected in the electrical driving of the auxiliary plant about a steelworks, large ranges of boilers have still been retained for supplying steam to the main rolling-mill engines driving the cogging-mills, roughing-mills, plate-mills, bar-mills, rail-mills, etc. It is, of course, well appreciated by all steelworks engineers that the bulk of the boiler power is required for supplying steam to these main engines. Until, therefore, it was found possible to deal in a practical manner with these main units, the realization of a complete electrification scheme was a matter of impossibility.

It is true that in a number of cases on the Continent and in Great Britain continuous rotation-mills of the three-high type, rod-mills, and others have been operated electrically in a successful manner, but until about nine months ago the problem of the successful employment of large reversing electrical rolling-mill engines was still unsolved.

ADVANTAGES OF ELECTRIFICATION.

The rolling-mills of England, in view of complete electrification schemes, may be divided into those which have blast-furnaces adjacent and those which have not.

The first questions which the author has invariably been asked naturally refer to what may be the financial gains and advantages to be derived from such electric rolling-mill equipments and complete electrification schemes.

These he will tabulate as follows:

(1) For rolling-mills with blast-furnaces attached. The possibility, now that the electric reversing-mill problem has been solved, of entirely dispensing with all coal-fired boilers and their attendant charges for firemen, conveyance of coal, removal of ashes, repairs, and insurance costs, &c., the electric power for operating the complete rolling-mill plant and auxiliaries being primarily derived from the waste gases of the blast-furnaces.

(2) For rolling-mills with no blast-furnaces attached. The entire removal of boiler plant as above in the case of a cheap outside power supply, or the great reduction in the number of boilers required for working the mills, and the generation of the power in any convenient spot within reasonable distance of the works, with high-tension mains to the rolling-mill balancer converters.

(3) Increased output, the rolling-mill motors being made to run at any desired speed direct coupled to the rolls. The speed of rolling being controlled only by considerations such as the rapid handling of the material and the mechanical strength of rolls and housings.

(4) Extreme simplicity of the direct-coupled electric reversing-mill, the whole operations of rolling, reversing, and speed regulation being controlled by one lever.

(5) Decreased cost of upkeep, as owing to the use of electric-motors with their continuous rotary action and regular torque, the breakages of coupling boxes, standards, pinions, and necks are reduced to a minimum.

(6) Absolute control over rolling-mill costs and power absorbed at any stage of all rolling operations, by the use of electric recording and automatic instruments, such exact control having been impossible in the case of steam.

(7) Gain in space formerly occupied by ranges of boilers, coal bunkers, railway sidings, &c., which in some overcrowded works, or where land is of high value, is an item of considerable importance.

(8) The great reduction in power used in connection with reversing rolling-mills, owing to the method of utilizing a balancing converter upon the Ilgner principle, the energy absorbed by the converter, which is derived direct from the central generating station or mains, being about one-tenth of the maximum value or torque upon the mill, even when the load fluctuates on the mill between 0 and 10,000 HP.

(9) In the event of new mills being laid down, the ease with which the rolling-mill motors can be applied direct to the rolls without the necessity of large and costly foundations, as is the case at present with heavy reciprocating steam rolling-mill engines.

(10) The very large reduction, in the majority of cases, of the power cost per ton of steel rolled, owing to the foregoing considerations. Less than twenty KW.-hr. are used per ton of blooms rolled, which, in the case of mills having blast-furnaces adjacent, or waste gases available, and producing electricity at ½c. KW.-hr. works out at under 10c. a ton.

*From a paper read before the Iron and Steel Institute of Great Britain, May 9, 1907.
†Newcastle-on-Tyne.

The foregoing are the main advantages which present themselves to the author, but to steelworks engineers several subsidiary advantages may become apparent, and it is to their intimate knowledge and practical experience of rolling-mill conditions that the author looks for further suggestions or criticisms, which he trusts will be fully brought out in a discussion upon this paper.

The intermittency of working of the various items embraced in the scheme at steelworks, rolling-mills, and collieries will come into full play, and the maximum load which will have to be provided for in the central station will be only a fractional part of the total HP. of the motors involved.

It is, however, in connection with the high-power reversing-mill engines that the greatest saving of all will be effected. Even the best steam rolling-mill engine, owing to its intermittency of working and rapid reversals, as exemplified in the case of cogging-mill engines, is necessarily a heavy consumer of steam. In some cases the exhaust steam from these wasteful engines has been utilized in low-pressure turbines, upon the regenerative principle, this until now being the best solution of a bad job. Since the successful application of electricity to reversing-mills, this can only be now considered as but a half measure, and one that does not touch the root of the evil, viz., the rolling-mill engines and their attendant ranges of boilers, &c.

THE HILDEGARDEHUTTE WORKS.

Having touched upon the salient points to be borne in mind in connection with complete electrification schemes for steelworks and rolling-mills, the actual methods by means of which these results are arrived at will now be dealt with, and this cannot be better done than by taking as an example the actual case of the Hildegardehütte at Trzynietz in Austrian Silesia.

This reversing-mill was started on July 27 last, and has been running ever since.

Having had the privilege of discussing details of construction, both mechanical and electrical, with the engineers who were responsible for the design of the electrical equipment, the author thinks that the following notes will be of interest to members of the Iron and Steel Institute who are desirous of making themselves acquainted with the latest and most up-to-date practice in rolling-mill design.

The Hildegarde Works were formerly owned by the Archduke Frederic of Austria, and within the last few years were purchased by a company. On assuming possession the new owners naturally set themselves to reconstruct the works in the best possible manner, and electricity was chosen as a means of bringing the plant up to a state of modern efficiency. The company wished to keep in mind the possibility of concentrating the whole of the power required for the works in one large central power-station.

As the author has mentioned, there had been many cases of successful driving of continuous rotation mills, but the question of a reversing-mill presented the difficulty. That this has been overcome by careful consideration is proved in the successful and highly economical running of the reversing-mill plant to-day.

After the decision to adopt electric driving had been arrived at, the question of the primary motive-power had to be considered. In this particular instance it was found that the advantages lay with gas-engines as the power-producers. It was proved, however, that two years would have been required to equip and set to work a gas-driven generating station of some 5,000 KW. capacity, and this was one reason against the installment of gas-engines. It was guaranteed that a steam-turbine station of the capacity mentioned could be installed and set to work within fifteen months from date of placing the order. The steam-turbine plant was decided upon, the orders placed, and the station in its full capacity was actually running in twelve months.

Another factor which induced the directors to decide upon steam as a motive-power was the presence of a well-preserved battery of boilers. Originally 54 boilers were required to raise steam for the whole works. Eight boilers are actually required to steam the electric power-station, all fired with gases from the blast-furnaces, and thus the whole of the power production is obtained on highly economical modern lines.

At the present time the plant driven is as follows:
One reversing rolling-mill, 10,350 HP. maximum;
One non-reversing mill, 750 HP. normal; and
300 motors varying from 5 to 70 HP.

In addition to the above must be included the electric lighting of the works.

A further extension is about to be made of two continuous rotation rolling-mills, each 750 HP. normal capacity, together with pumping and other auxiliary plants about the works. When these are completed the whole of the power items, with the exception of the blowing-engines, will derive their power from the one electric power-generating station.

A passing mention of the continuous rotation mill will not, the author thinks, be out of place in this paper. This mill is three-high, and calls for a normal of 750 HP.

The present mill installed is regarded as a roughing-mill. A second mill is now being equipped on the same lines, and will be of the same size. This will be the middle mill, and a further rod-rolling mill is being installed of the same capacity. The existing non-reversing mill is rope-driven by three-phase motors. On account of the different classes of its work it was deemed necessary to have two speeds on the mill, and these are obtained in an unusual manner by having two motors, one running at a speed of 210 r. p. m., and one running at a speed of 160 r. p. m., both coupled together, and driving the mill from one end by means of ropes. The idea of having two motors was to obtain economical conditions of running on both the fixed speeds. Intermittent speeds are also arranged for. The motors are three-phase, and are run direct off the 3,000-volt high-tension circuit. Only one of the motors is used at a time; a change-over switch transferring the load to one or the other, depending on the speed required. The rope-pulley on the mill itself is of a heavy flywheel pattern of cast iron.

The reflected load of this mill, of course, makes itself shown in the rising and falling of the current demanded at the time of the entrance of the blooms or billets. However, the heavy flywheel on the mill damps this down, and there is no doubt that three-phase motors coupled by a rope or belt on to a non-reversing mill form a satisfactory method of driving.

THE REVERSING MILL.

The item which constitutes the main interest of this paper, the reversing-mill, consists of one train of rolls, with four sets of housings, the roll centers being 2 ft. 6 ins. apart normally. Originally this mill was driven by a direct-coupled steam-engine of the twin-cylinder horizontal type, having cylinders 48 ins. diameter by 50-in. stroke, running at a maximum speed of, approximately, 100 r. p. m. The steam pressure was six atmospheres at the stop-valve.

The duty of the mill is to roll ingots of a maximum weight of two tons having dimensions 16½ ins. square plus 18 ins. square, by approximately 5 ft. 6 ins. in length; cogging these ingots down to suitable billets for rails, girders, etc., and proceeding further to roll them into girders and rails. The maximum size of I-beam rolled in the mill is 18 ins. deep by 7 ins. wide, and the usual heavy sections of rails are also rolled.

The mill thus combines cogging, roughing, and finishing in one operation, and the time allowed for the complete rolling of the largest girder section from ingots is from 5½ to 6 min.

On the conversion of the mill to electric drive the engine crank-shaft was taken out and replaced by a length of straight shafting, the shafting being continued through into an adjoining house built to accommodate the electrical plant and apparatus.

It was decided to increase the speed of the mill up to 120 r. p. m. maximum, with a certain margin, and, as a matter of fact, it is possible to accelerate the mill up to as high a speed as 140 r. p. m., which comes in very handy in the final passes of long work.

The reversing mill shaft above referred to is extended through into the house, and coupled to it, upon one shaft, are three continuous-current motors. These three driving motors are each of the following capacity:

330 volts, 120 r. p. m., 1,200 normal to 3,000 B.HP. maximum, to which must be added an extra overload capacity, bringing the total capacity to a maximum of 10,350 B.HP. For convenience of manufacture, the shaft carrying the armatures of the three motors is divided into three, with rigid couplings fixed between the motors.

The flywheel balancing plant, consists of one three-phase motor, coupled through flywheels to one continuous-current generators, on either side. This balancer is on the Ilgner system, and is the crux of the whole situation, forming the medium whereby the excessive peaks caused by rolling and reversing are reduced to a mean, straight, and comparatively low load-line demand from the power station.

In passing, figures of the capacity of this balancing plant will be of interest.

The three-phase motor in the center derives its energy from the 3,000-volt circuit. The two flywheels forming the intermediate buffers between the motor of the Ilgner set and the two continuous-current generators are each 13 feet in diameter, and weigh 26 tons each. Water-cooled brakes are provided on the flywheel peripheries for stopping the set, when required, in a short time. The motor capacity is 393 amperes, 3,000 volts, 50 cycles, running at a speed of 370 to 310 r. p. m. Automatic liquid rheostats insert resistance into the rotor of the three-phase motor driving the balancing set, thereby dropping the speed of the set and permitting the two heavy flywheels to give off their energy.

The armatures of the two continuous-current dynamos on the balancing set are connected in series with each other, and directly in series with the three armatures of the rolling-mill motors. Thus there is no interruption or break whatever in that portion of the circuit carrying the large main currents.

Three machines coupled together form the starting and excitation machines. The center machine is a three-phase motor which receives its energy from the

high-tension circuit at 3,000 volts. The maximum capacity of this machine is 150 HP. when running at a speed of 585 r. p. m. The topmost machine consists of the continuous-current dynamo for exciting the shunt of both the mill motors and Ilgner generators, while the lower machine provides current for the excitation of a special compound winding upon the three rolling-mill motors.

Great difficulties beset the designers in the first instance, for it must be understood that no reversing-mill of any magnitude having been driven electrically previous to the conception of this one, there was absolutely no trustworthy data upon which to base the necessary calculations.

The load demanded is of a varying quantity, from zero to as much as 8,000 HP. in the space of a few seconds, rising and falling continually during the operations.

The supplying of current for driving mill motors of this description directly from the network of a central station or from a power-supply source would have very undesirable effects on account of the enormous fluctuations in the load. It would be necessary to have a reserve, varying according to the nature of the mill, from 8,000 to 10,000 HP. in the central station, and, moreover, the cables and the controlling apparatus would have to be dimensioned to meet the corresponding output. A method of keeping the load from exceeding a predetermined maximum is absolutely essential. It would have been impossible also, with the methods known, to have connected an installation of this description directly on to a network where constant voltage has to be maintained, and even if controlling apparatus was available it would hardly be possible to handle it in the exact manner necessary in the rolling-mills. Finally, it was of great importance to select a means of regulating the speed of the driving motors, which would obviate the losses involved in reducing the applied voltage.

All these conditions were complied with by what has become known as the Ilgner system, consisting of an arrangement of flywheel converters. The details of this system are known through its application to electric driving of colliery winding-engines. The Ward Leonard system of control used by the Ilgner system has found many practical and successful applications. The special feature of this method of control is that the motor is fed from what is termed a starting dynamo, and its speed can be varied from zero up to the maximum by varying the voltage applied to the brushes, which is dependent on the excitation of the flywheel generators. As before mentioned, the commutators of the motors and the generators are connected electrically in a closed circuit without any break whatever. The generators of the Ilgner set driven by their motor run unexcited, and, therefore without load, so long as the mill motors are not required to run. When it is desired to start up the motors it is only necessary to excite the flywheel-set dynamos from an outside source. The magnetic field thus created induces an electro-motive force in the armature of the flywheel generators and the current flowing through the armatures of the motors brings them into motion. The pressure at the terminals of the motors and their corresponding speed vary with the value of the excitation of the Ilgner dynamos, and, by reversing the direction of the excitation in the dynamos, the direction of rotation of the mill motors can also be reversed. The amount of energy required for exciting the dynamos is known to be only a small proportion of its output, never exceeding about 3%, and it therefore follows that when control is introduced into this part of the circuit the quantity of energy used is very small. Moreover, the controlling apparatus has only to be constructed for dealing with small currents, and is consequently very easy to manipulate. It also follows that by starting and regulating between rest and full load there is no loss in the energy, as only that amount of pressure and corresponding energy necessary for the excitation of the Ilgner dynamos is generated.

As a matter of fact, the most remarkable part of the installation is the simplicity of control, and the small dimensions of the controlling apparatus; one man with a simple controller, having a single lever, performs the operations of running, reversing, and controlling the mill. The whole apparatus is contained in a case having dimensions not exceeding 3 ft. 6 ins. long, by 3 ft. wide, by 3 ft. 6 ins. high. The whole operation is carried out by a simple to and fro motion of a single lever. The maximum controlling current would certainly not exceed 150 amperes, and one can readily understand that this can be far more easily dealt with than such currents as 8,000 to 10,000 amperes, as would be required if the main currents had to be controlled.

Referring to the construction of the flywheels; these are of cast steel carefully machined all over, balanced and polished, and have a peripheral velocity of 260 ft. per sec. corresponding to a motor speed of 375 r. p. m. The purpose of the flywheels is, of course, well known; if large rotating masses are used which have to give up energy at certain periods, it is a condition that the motor which is to be helped by flywheel effect shall drop in speed as the load on the driving machine rises. A shunt-wound direct-current motor running at a constant speed would never share its load with a flywheel coupled to it. The same applies to a three-phase motor with a short-circuited rotor where the slip between no-load and full-load is only 2½%. It is therefore necessary to cause the motor driving the flywheels and dynamos to drop in speed.

For the speed control of this plant liquid resistances (as already referred to in the description of the plant) are used, consisting of metal plates suspended in a tank of slightly acidulated water. The depth of the plates in the liquid and the corresponding value of the resistance is not altered by hand, but by means of a small motor, the armature of which can rotate for a certain number of degrees in either direction corresponding to the movement which is necessary for the resistance plates. The armature of the small motor carries for this purpose an arm, on one end of which the ends of the resistance plates are connected, and to the other end of which is a balancing counterweight. This small motor, which we call the slip motor, is fed with current from the stator of the Ilgner motor. In this manner there are three moments acting on the axis of the rotor; the one due to the weight of the electrodes, another to the counterweight, and a third to the torque of the main motor itself. At the mean current necessary for rolling, these three moments are in balance. If there is a rise in the current taken by the rolling-mill motors, the turning moment of the small slip motor increases as the square of this change, and disturbs the balance of the three turning moments whereby the electrodes are raised, increasing the resistance in the rotor circuit and therefore the slip of the motor of the converter. The flywheel consequently gives up energy until the balance of the three turning moments is once more restored. By altering the counterweight on the balancing arm it is possible to regulate the required mean energy to be taken from the main. This slip regulation is extremely simple, absolutely automatic, and, of course, contains no relays or intermediate apparatus which might cause trouble. The result obtained by this constant current control of the flywheel generator is that, although the rolls may take momentarily as much as 10,000 HP., the energy taken from the mains is only one-tenth of this amount, viz., 1,000 B. HP. It might be thought that the time required for starting up the flywheel balancer would be considerable. The author has seen for himself that this did not exceed eight minutes from start to full speed.

The energy absorbed by the three-phase motor driving the balancing set varies from 5 to 800 KW. during the starting up of the set. The time can of course be reduced by a corresponding increase in energy taken. The no-load energy of the flywheel converter is 120 KW.

Reference has been made earlier in the paper to the compromise arrived at with the Hildegardehütte in regard to the time taken for the acceleration of the rolls from rest to full speed. It was agreed that four seconds should be allowed. Tests subsequently proved that the given conditions had been fully met. A speed of [illegible] r. p. m. was obtained without difficulty and with the current estimated upon, and it was found possible to accomplish the acceleration from 0 to 110 r. p. m. in 2 to 2½ seconds. The mill has not been stopped for any appreciable time when changing the direction of rotation. This results from the fact that the driver throws over the operating lever from the position of full speed in one direction into the opposite direction, whereby the motors receive a braking current. This quick reversal and acceleration has been taken advantage of according to the work handled, and with but little practice the operator soon comes to know how to handle the mill so as to get the most out of the improved method of driving.

Although in rolling 18-in. beams the current impulses frequently reach 7,000 amperes, the energy taken from the converter amounts to 4,500 KW. maximum; the biggest fluctuations observed in the central station are only 200 to 250 KW. Practice confirms the calculations that balance is better obtained the quicker the work is carried out—that is to say, the fewer the pauses there are in rolling. It will be admitted that the balance of energy secured by these flywheel converters is nearly perfect, apart from the advantage that for any particular rolling programme the maximum energy taken from the power station will not exceed a certain predetermined value.

It will be seen that such an electrically driven mill as the one described constitutes an excellent load to have connected to any station, especially as the rotating masses of the flywheel act to a large extent as a balancer for the whole system.

Further figures, taken by the author when the mill was rolling a thick bar section 12½ ins. wide by ¾-in. in thickness, may be of interest. The average time taken in the complete rolling of one of these bars from the ingot was from five to five and a half minutes. During one particularly quick period, when the bars followed quickly one after the other, the reflected load rose to 1,150 KW., which was the maximum we saw reflected on the wattmeter; but this gradually fell away, and for some time afterwards 750 KW. was the average reflected. During these periods the maximum current that passed through from the Ilgner dynamos to the rolling-mill motors was 8,000 amperes on each side of the [illegible], and the maximum voltage reached during these [illegible] was 1,000. It is interesting to see how the current passing from the Ilgner dynamos to the mill motors, the voltage of the Ilgner dynamos, and the speed of the motors rise and fall together, while the current taken by the Ilgner motor and the kilowatts reflected on the generating plant remain almost constant, excepting in the pauses between the actual rolling are longer, at which time the current on the Ilgner motor and the watts reflected gradually fall off.

The whole of the rolling-mill and central station equipment just described represents one of the most carefully thought out and practical schemes it has ever been the author's privilege to inspect; with nothing before them in the way of precedent to guide them, the designers have successfully accomplished a feat in which they may justly be proud, and the author cannot let this opportunity pass without firstly thanking the designers and experts, Mr. Geyer and Mr. Riecke, of Berlin, for the help they have rendered him in the preparation of this paper, but must also congratulate them upon the successful outcome of their work.

The author is indebted to the directors of the Hildegarde Works for the facilities given him in the necessary study and inspection of their rolling-mill.

The actual installation of the electric rolling-mills and central station has been carried out by the Allgemeine Elektricitäts Gesellschaft of Berlin.

The first reversing rolling-mill just described has only been in operation about nine months, and already the Continental steel works owners and engineers have lost no time in availing themselves of this new innovation.

Two electric reversing rolling-mills, of 10,000 HP. each, have been started up at the Resicza Iron Works in Hungary, while another electric reversing-mill of 15,000 HP. is being erected at the Rombacher Iron Works, near Metz, and yet another is to be installed at the Hüstener Works, Hüsten.

It will therefore be apparent, from the rapidity with which the matter has been taken up on the Continent, what very great importance is attached to the subject.

Indeed, in the author's opinion, the day of the electric rolling-mill has come, and it has come to stay. The preliminary electric rolling-mill equipments to which he has alluded are but the first stepping-stones to a complete revolution in the methods of rolling iron and steel.

THE SANITARY SUPERVISION OF PUBLIC WATER supplies in Kansas seems to be quite effectually provided for by an act of the Kansas Legislature, approved on March 13, 1907, and published in full in Bulletin No. 3 of the Kansas State Board of Health (Topeka, Kans.). The act defines waters of the State as including "all streams and springs, and all bodies of surface and of impounded ground-water, whether natural or artificial." It requires every municipal corporation, private company or individual supplying water to the public to file with the State Board of Health, within 60 days from the passage of the act, "a description of the source from which the supply of water is derived," and prohibits drawing upon any additional source of supply hereafter without having first obtained a written permit from the board. Hereafter no new sewerage systems can be built, old ones extended, and no sewage discharged from new outlets by any person, company or municipality, without first having obtained a permit from the State Board of Health. Such permits when granted may be ordered discontinued after a hearing called for and held by the Board. Reports of existing sewerage systems must be made to the Board within four months from the date of the publication of the act, and if satisfactory reports are not made it will be unlawful thereafter to discharge sewage into the waters of the State from the sewerage systems in question. Although the discharge of sewage from existing outlets is permitted under the condition just stated, the Board has power at any time to order the discharge discontinued, if in its opinion such discharge "may become injurious to the public health." Provision is made for court reviews on appeal, in connection with any order of the State Board of Health under the act in question.

THE CRIPPLE CREEK DRAINAGE TUNNEL, an account of the opening of which appeared in our issue of May 30, has been driven but 75 ft.; still, the fact that the contract has been let and the construction got under way is apparently having its effect upon mining operations at Cripple Creek. Several companies are reported to have made plans for sinking deep shafts, although they will have such work completed long before the tunnel will have become a factor in their drainage; the fact that ultimately the lower levels of such workings will be kept free of water without pumping seems to justify incurring the expense and the necessary pumping meanwhile.

NEW IDEA IN ROTARY DRYERS.

A rotary dryer possessing features of considerable novelty has been developed by the Atlas Dryer Co., of Cleveland, O. The fundamental idea of the new dryer, which is the invention of Mr. W. M. Cummer, President of the company, is that of bringing into direct contact with the material to be dried a greater quantity of the heated air and products of combustion from the furnace than is possible with the ordinary form of cylindrical rotary dryer, where the heat passes into and through the cylinder in a direction parallel with the axis.

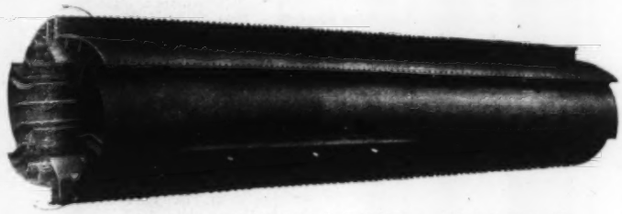

FIG. 1. GENERAL VIEW OF CYLINDER, ATLAS DRYER.

The manner in which the problem has been solved by the inventor is very clearly shown in Figs. 1 and 2. From the basic idea of drawing the heated gases through a screen and through ore or other material to be dried, resting on the screen, was evolved the sectional cylinder, Fig. 1, so designed that the hot gases and air can be drawn through the periphery and into direct contact with the material, the latter being kept constantly "cascading" by the vanes or lifting blades, shown in Fig. 2, as the cylinder rotates in a clockwise direction when viewed from the furnace end. The inclination of the cylinder, of course, keeps the material moving longitudinally.

The cylinder, as will be seen from the cuts, consists of six curved sections held together by six channel irons running the entire length of the sections. In the channels are slotted openings for the admission of the heated air and gases. By reference to Fig. 2 it will be seen that there are six broad, curved lifting blades directly opposite and inside the openings in the channel irons; these perform the dual duty of guarding the air passages, thus preventing the drying material from falling out, and of lifting and cascading the material. The broad blades are assisted in the latter function by the small lifting blades.

A casual consideration of such a cylinder, with peripheral openings of considerable size, is apt to lead to the impression that the material within the cylinder will, in operation, fall through the openings. A study of Fig. 2, either imagining it to rotate or actually rotating it in a clockwise direction, will show how this is impossible. Take the air inlets at the bottom and right of the cut; they are cut in a surface which is in a radial plane; as it rotates under and to the left, material from the blades already up on the ascending side does not commence to fall into the "pocket" formed between the blade and the channel iron until the radial plane of the web of the channel is well past the vertical and the openings consequently at the upper side of the "pocket." Material from the small lifting blades does not fall into the larger until that plane is almost horizontal, hence none of the material can leave the cylinder.

Fig. 3 shows the method of installation of the dryer. The cylinder is surrounded by a steel casing, into which pass the heated air and gases from the furnace. An exhaust fan "E" draws the heated air through the openings into the cylinder, through the falling material within, and out at the exhaust. Set along the base of the casing are doors "G," which may be opened to reduce the temperature of the air and gases from the furnace before their delivery into the cylinder. The relief stack shown in Fig. 3 is used in starting the fire—if solid fuel be used—to carry off the smoke until the furnace becomes hot and when the dryer is to be shut down. By operating the damper, the heat is carried off without burning material then in the cylinder.

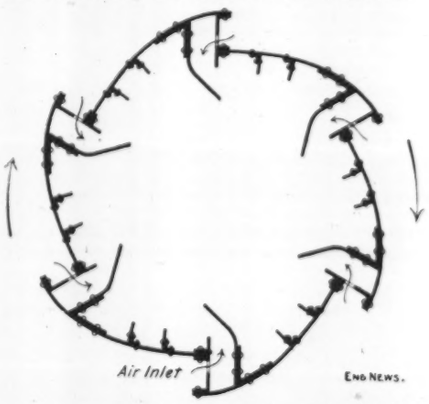

Fig. 2. Cross Section of Atlas Dryer Cylinder, Showing Air Inlets and Lifting Blades.

Material to be dried is fed into the furnace end, and by this inclination of the cylinder is fed along to a discharge bin or hopper at the other end.

In the equipment shown in Fig. 3 the furnace is coal burning, with a mechanical stoker "F" driven from the rotating mechanism. Gas may be used as a fuel with advantage; or in fact any fuel which may be available, the only change necessary being in the furnace.

The dryer will handle to advantage ore of various kinds; sand, for asphalt paving; stone, clay, marl, etc., for cement plants; coal, before pulverization for use in cement plants; wood chips in paper mills; blood, bones, etc., in packing plants; brewery grains and distillery "slops"; or any material of these sorts, coarse or fine.

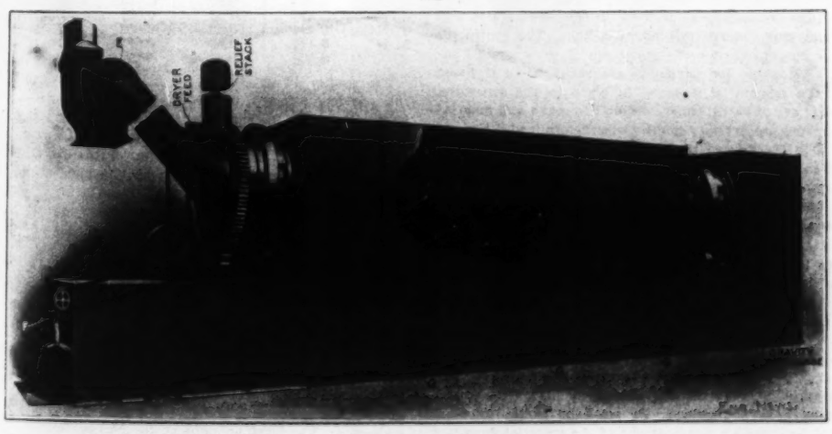

FIG. 3. ATLAS DRYER AS INSTALLED. STEEL CASING CUT AWAY TO SHOW CYLINDER.

NOTES ON PREPARING SPECIFICATIONS: U. S. RECLAMATION SERVICE.*

In all cases where formal advertisements are to be issued inviting proposals for material or labor for works of repair or construction, it is required that complete specifications be prepared and printed sufficiently in advance of the date for opening proposals to enable all parties desiring to bid under the advertisement properly to prepare their proposals. A general form for preparing and publishing these specifications has been developed, in which the specifications are divided into and assembled in the order of the advertisement, notice to bidders, proposal, including guaranty of bond and schedules, general conditions and detail specifications. Each set of specifications should be submitted in duplicate, and one of these copies should include in the schedule the itemized estimated cost of the work or material. This estimate is necessary in order to determine the amount of the certified check and bond, and must be transmitted with the advertisement, proposal and specifications to the Secretary of the Interior. The standard specification paragraphs should be used in the preparation of specifications as far as practicable. Their being called "standard" does not mean that they are inflexible, but that their general forms are to be adhered to with such modifications as local conditions or special requirements may render necessary. Some paragraphs are inserted that will ordinarily not be required, but that may be found applicable in special cases. Proportions of materials to be used in concrete, the sources from which such materials are to be obtained and matters of a similar nature must in each case be determined by the engineers in the field.

THE ADVERTISEMENT.

The purpose of the advertisement is to attract the attention of contractors and to inform them where information relating to the work can be obtained. To this end the advertisement should always be as brief as possible, stating in a few words the time and place of receiving and opening proposals, the character and quantity of work and the source from which detailed information may be obtained. The advertisement should have a heading that indicates the character of the work for which proposals are invited. For example, Tunnel, Concrete Dam, Canal, Pumping Plant, Telephone Line and the like.

THE NOTICE TO BIDDERS.

The object of the notice to bidders is to advise prospective bidders of the required amount of certified check and bond and to give such other information as may directly relate to the preparation of proposals. It should, therefore, be clear, concise, definite and complete for the purpose intended.

THE PROPOSAL.

The proposal is intended to contain a distinct proposition as to the work to be done or material to be furnished and the prices at which the work is to be performed and material supplied; and also an agreement to enter into a contract to begin and complete the work or delivery of material in accordance with the specifications and to forfeit the required certified check to the United States in case of failure to execute a satisfactory contract. The schedule should be prepared with great care, the work or material being so classified as to place work distinctive in character and cost under a separate item, and so as to include all work or material described in the specifications or shown in the plan, the payment for which is not otherwise provided for in the specifications. Conversely, a description should be given in the body of the specifications of all items appearing in the schedules. In asking for proposals for machinery and other classes of material where it is desirable to make payments only at certain defined stages of the work, care should be exercised to itemize the material in the schedule minutely enough to permit of payments on partial delivery of the material; an item could well be provided in the schedule for each complete unit. It is not desirable, however, to itemize work or material too minutely in the schedules, especially where the work or material is an essential element of other larger units. For example, in timber structures the payment for lumber in a structure, or of a lump sum therefor, should include all necessary bolts, spikes and other nails. For the purpose of subdividing the work, canal construction may be divided into a number of divisions and sections, and the work in these divisions or sections may be enumerated separately in the schedule under proper titles. A division may, if desirable, include a number of canal sections. It will frequently be necessary to make the statement that all the canal work of each section as enumerated in the schedule will be awarded as a whole to the best bidder for the work in that section.

AUXILIARY WORK.—When the work covered by specifications must be done in a prescribed order, as for instance, in the case of a masonry dam where a diverting dam and a diverting flume or tunnel must be constructed in advance of the placing of any masonry, unit prices or lump sum bids should be requested for the useful work in

*Compiled in the Technical Section of the U. S. Reclamation Service. Mr. F. H. Newell, M. Am. Soc. C. E., Washington, D. C., is Director of the Service, and kindly sent us the notes, with the privilege of publication.—Ed.

the structure. The masonry should be paid for and not the coffer dam around the pit in which the masonry is placed or the pumping plant that may be necessary to keep the pit dry or even the pumping; and when it will not impose too great a burden on the contractor, separate payments should not be made for the diverting dam, flume or tunnel. When, however, it is thought best to pay for preliminary work separately, it is preferable to name in the schedule a lump sum that will be paid therefor than to ask for a bid for its construction. If separate bids are requested for such temporary works or for the masonry that has to be placed in the base of the dam under greater difficulty than the masonry in the upper portion of the structure, the experienced contractor will always take advantage of any opportunity thus offered and will bid high on all work that is required to be done before other work. He may, if he does not fear rejection due to the unbalanced condition of such a bid, place exorbitant prices on the first work to be done and make his prices nominal for later work.

When for good reason opportunity is given to a contractor to bid at one rate for the foundation work of a dam, and at another rate for the work done in the upper portion of the dam, there should be some restriction on the difference between the two prices. This restriction is frequently covered by a statement that a proposal containing an unbalanced bid may be rejected; but it is better to limit the allowable difference. This limit should be expressed specifically, as, for instance, $2 per cu. yd., rather than in a percentage of either of the two prices.

ALTERNATIVE BIDS OR PROPOSALS.—So far as practicable, alternative bidding should be avoided; but when sufficient reason exists alternative bids or proposals may be requested on two or more described plans of doing work. When the plans are of equal merit and the award is to be made to the lowest and otherwise best bidder, this should be so stated in the specifications; and when one of two or more alternatives is the best, a definite basis of comparison should be stated.

FIXED PRICES.—It will sometimes happen that the amount of a certain class of work of relatively small importance can not be foretold with any degree of precision in advance. In this case it is often better to name in the schedule and in the specifications the price that will be paid rather than to ask the bidder to name a price. Overhaul, hauling cement or steel and placing steel in concrete are examples.

GENERAL CONDITIONS.

Three sets of general conditions have been prepared for use: First, form 9-294, Construction; second, form 9-294a, Machinery and Installation; third, form 9-294b, Material. These forms apply specifically to the subjects indicated by their titles and should be used for advertisement for these particular purposes. These general conditions contain the requirements that are common to all sets of specifications of their particular kind and have been revised from time to time to meet the requirements of the Department of the Interior and of the conditions of the work as contingencies have arisen. In the preparation of specifications these general conditions should not be changed.

THE DETAIL SPECIFICATIONS.

The detail specifications must necessarily be prepared for each advertisement and should be compiled from the standard paragraphs by modifying them where necessary and by adding such other paragraphs as are needed. In the preparation of these details great care should be taken to make them logical, complete, clear, definite, consistent and concise. The language of the specifications, supplemented by the plans, should be such as to formulate in the mind of the contractor the exact character of all the work required, the manner of performing it, when this is limited, and the basis of payment for the same. The opening paragraphs of the detail specifications containing "The requirement," "List of drawings," "Supplies, materials, and services furnished to the contractor," "Failure to complete work in time agreed upon," "Progress estimates and payments" and other paragraphs referring to the whole work should be grouped under the center heading of "General Provisions." Succeeding these in logical order under appropriate center headings, such as are used in the standard paragraphs, should appear the paragraphs describing the required work and material.

THE REQUIREMENT.—In "The requirement" there should be stated specifically and clearly at the close of the opening statement given in the standard paragraph on this subject the character of the work to be done, including a reference to its purpose and location.

LIST OF DRAWINGS.—Under "List of drawings" there should be placed a list of the drawings accompanying the specifications. The titles of these drawings should agree exactly with those on the drawings themselves, and care should be exercised in naming each drawing to make the title significant of the design shown on the sheet.

SUPPLIES, ETC., FURNISHED TO THE CONTRACTOR.—The paragraph on "Supplies, materials and services to be furnished to the contractor," while included in the standard paragraphs, is intended for use only in exceptional cases. The necessity for its provisions should be clearly apparent whenever it is used.

PROGRESS ESTIMATES AND PAYMENTS.—For those items in the contract for which prices are named that are applicable only to finished portions of the work, as in the case of ditches per mile or tunnel per linear foot, and for items covered by lump sum bids in the absence of provisions for payments on account at specific stages of progress, a general clause, reading substantially as follows, should be placed after the first sentence in the paragraph on "Progress estimates and payments": "In the case of items Nos ..... the amount to become due on a progress estimate will be determined by the engineer by making an estimate of the value of the work done and material delivered at the end of each calendar month, based on the relative value of this work and material to that of the finished work at the prices named in the contract for these items." For the purpose of eliminating so far as may be practicable any uncertainty concerning the basis for such progress estimate, there should follow an additional statement to the effect that in making this progress estimate certain portions of the required work, as for instance the delivery of lumber, will be considered as representing ..... per cent of the price named for item ....., and so on. In the case of any particular item to be paid for in a lump sum, the statement may, of course, be made when necessary that no part of the lump sum will be allowed in any progress estimate until the work covered by the lump sum has been completed. It is always proper, however, in the case of any lump sum items to state that when the work or delivery of material or installation of machinery has reached certain clearly defined stages, certain partial payments specified in percentages or otherwise will become due and will be allowed in the monthly progress estimates.

CLASSIFICATION OF MATERIAL.—In classifying material under excavation a class number should always have the same significance. In cases in which it is certain that no material of a particular class occurs that class may be omitted from the specifications. It is better, however, where there is any doubt to state that the available information indicates that no material of that class is expected and that an arbitrary amount has been assumed for insertion in the schedule. In addition to the classification of materials in excavation as ordinarily made, a further classification is sometimes necessary, according to the nature of the work. It may, for instance, be necessary to require bidders to name a special price for "wet excavation." In this case "wet excavation" should be defined as the material below a specified elevation, or when such elevation can not be named, then as the material below the ordinary water level or excavation in land normally saturated with water. In addition to the ordinary items for earthwork there should then appear in the schedule:

Wet excavation:
Class 1 .....
Class 2 ..... } as the case may require.
Class 3 .....

So also in the case of concrete there may be necessity for further classification when the work includes a number of widely scattered small structures, and there may then appear in the schedule:

Concrete in minor structures:
Class A .....
Class B ..... } as the case may require.
Class C .....

MEASUREMENT.—In preparing paragraphs on measurement and payment it is desirable whenever this can be done to make measurement and payment on the basis of the quantity of material placed in the required structure. The measurement of work in the structure is logical and may prevent misunderstanding. The contractor is held responsible for the protection of work against injury. Estimates for payments are easily made if based upon the amount of material in place in the structure, but they are often extremely difficult to make and may involve much uncertainty if otherwise determined. For example, in the case of the construction of an earth dam it is often impracticable to make estimates based on the measurement of borrow pits that may be widely scattered, may be very irregular in outline and in depth and may be so shallow as to make accuracy of measurement impossible. If the measurement is made of the material placed in a levee or in a dam, there can be no issue raised as to the amount of damage done by storms or floods. On the other hand, if the measurement is made of a borrow pit, controversy may arise in case of damage to the work or its partial destruction relating to the amount of work that should be paid for. Both the levee and the borrow pit may be so disfigured as to make impossible a close estimate of useful work that had been done.

Examples: The payment for work on levees or dikes should be based on measurement of the material deposited in the embankment rather than on the measurement of the borrow pits from which such material is taken. The contractor should be paid for all material deposited, measured to the prescribed lines of the work, even though there is included within these lines an allowance for the ultimate settling of the embankment. It may be desirable in some cases to make exceptions where the material comes in large part from useful excavations, such as wasteways, tunnels, etc., but even in such cases there will be no confusion if both the useful excavation and the required embankment are paid for. Stripping should be measured in excavation. Ordinary canal work should be paid for by the cubic yard excavated.

LUMBER.—In preparing specifications for [illegible]ber the rules and specifications for the grading of lum[illegible] adopted by the various lumber manufacturing associa[illegible] of the United States should be followed in so far [illegible]ey are applicable. These rules have been collected a[illegible]blished by the United States Forest Service in Bulle[illegible]1. The standard specification paragraphs for lumber [illegible]ve been based on the information contained in this b[illegible]in, the specifications for each kind of lumber being [illegible]rmined from the association rules below indicated:

Redwood: Redwood Manufacturers' Associati[illegible] Grading rules adopted in 1900.

Douglas Fir: Pacific Coast Lumber Manufactu[illegible]rs' Association. Revised rules adopted March 30, 1906.

Yellow Pine: Yellow Pine Manufacturers' A[illegible]ociation. Revised rules adopted January 24, 1906.

Montana Lumber: Flathead Lumbermen's [illegible]oard of Trade. Rules adopted April 1, 1906.

CEMENT AND STEEL.—The standard paragraphs on cement and steel should be preceded in the preparation of specifications under the center head of "General Provisions" by paragraphs on "The requirement," "Time of delivery," "Failure to complete delivery in time agreed upon," and "Progress estimates and payments." These paragraphs should be similar to those provided in the standard paragraphs under the subject of "General provisions," and may be completed from them by making slight suitable modifications.

THE INFLUENCE OF NICKEL ON CAST IRON.*

By JAS. B. WEBB.†

In reporting on the tests authorized by this association last year, I beg to submit the following results: I made twenty test bars, ten with the nickel added and ten without, all from the same ladle holding 1,400 lbs., and of good hot iron. Nickel thermit was put into the bottom of the hand ladles, the aim being to get varying proportions of nickel into the metal and then to note the results of the tests.

The determinations were made by H. E. Smith, of the Lake Shore Railroad, and are presented herewith:

TABLE I.—PHYSICAL TESTS. CAST-IRON TEST PIECES FROM ELKHART, IND.

Mark.	Diameter, ins.	Cross breaking, weight.	Deflection.	Modulus of rupture.
1 N	1.25	3,000	0.11	46,870
1 N	1.24	2,970	0.09	47,520
2 N	1.24	2,510	0.08	40,160
2 N	1.26	2,820	0.10	43,010
3 N	1.26	3,000	0.10	45,790
3 N	1.25	2,690	0.09	42,020
4 N	1.26	3,130	0.09	47,710
4 N	1.23	3,010	0.09	49,330
5 N	1.25	2,370	0.08	37,030
5 N	1.23	2,570	0.09	42,130
1 X	1.26	2,990	0.08	45,660
1 X	1.26	2,790	0.09	42,550
2 X	1.26	2,740	0.10	41,790
2 X	1.25	2,890	0.10	45,140
3 X	1.26	2,750	0.08	41,950
3 X	1.23	2,690	0.10	44,100
4 X	1.25	2,610	0.09	40,780
4 X	1.23	2,770	0.10	45,410
5 X	1.25	2,470	0.09	38,600
5 X	1.25	2,760	0.09	43,130

Tests on 1¼-in. round bars, supports 12 ins. apart.

TABLE II.—CHEMICAL ANALYSIS.

Mark.	Manganese.	Phosphorus.	Sulphur.	Silicon.	Nickel.
1 N	0.460	0.63	0.090	2.07	0.67
2 N	0.455	0.63	0.089	2.08	1.18
3 N	0.450	0.63	0.091	2.05	2.07
4 N	0.444	0.62	0.087	2.02	3.25
5 N	0.444	0.63	0.088	2.10	6.65
3 X	0.450	0.62	0.086	2.12	—

The results do not indicate a marked improvement in the physical strength of the castings, and bear out the supposition that nickel in cast iron is either not distributed uniformly enough to do much good, or else will find its best use in special classes of the metal freer from the high percentages of impurities incident to the ordinary casting.

It is to be hoped that further experiments can be made to prove just what does happen when nickel is added to cast iron, and I take pleasure in giving the above results as a contribution to the literature of cast iron when nickel is added to the ordinary grade.

DAMAGES FOR THE DIVERSION OF UNDERground waters are claimed in a suit brought against East Orange, N. J., Mr. Frank W. Meeker, a farmer of Livingston, N. J. Mr. Meeker asks for $10,000 damages on account of the alleged drying up of springs on his farm subsequent to the use by the East Orange water-works of 20 wells sunk by the department at White Oak Ridge in the township of Millburn, about one-quarter mile from his place. The springs were used for watering cattle and cooling milk. He also claims that the yield of certain hay fields has been reduced in the ratio of 20 to 6. It is said that this is the first lawsuit of the kind brought in the State of New Jersey.

*Presented at Convention of American Foundrymen's Association, Philadelphia, May 21.
†Supt., Foundry Dept., Lake Shore & Mich. Southern Ry., Elkhart, Ind.

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In our issue of May 30 we called attention to the recent consolidation of the two rival railway enterprises in the Borough of the Bronx, New York City, as an illustration of the fact that competition in street railway service cannot exist except as a temporary condition. We also suggested that this fact should be recognized by those charged with the duty of safeguarding the public interests; and that the New York Railroad Commission should not have approved the issue of stock and bonds by the two rival enterprises.

We now learn, however, that in our criticism of the Railroad Commission, we were misinformed as to the facts; that the Commission's approval of the stock and bond issues was not given until after the virtual consolidation had been arranged; and further that the approval contained the express requirement that the combined security issues by the companies should not exceed the total amount originally provided for one of them.

Old errors die hard; and the old delusion that competition is the great safeguard of the public against extortion still persists in the minds of a great number of people. Even though a public official fully understands that competition in public utility service is undesirable for the public interests, it frequently happens that he cannot act in favor of establishing a monopoly service without incurring charges of corrupt favoritism which may ruin his opportunities for further usefulness.

Fully understanding this situation, we are by no means disposed to criticise with undue severity public officers who yield to the pressure of public opinion in favor of the grant of competing franchises. We are the more pleased, however, to record a case where a broad view of the matter is taken. Particularly at this time, when the New York Railroad Commission is about to be legislated out of existence, are we pleased to record that its official acts in the matter above set forth have been, based to the best of our knowledge, on sound economic principles.

The delays of freight cars in railway yards, and the relation of such delays to yard improvements and car efficiency, were discussed editorially in our issue of April 4. Since the publication of that article we have received some additional information in regard to the detention of through cars at intermediate yards and of local cars at their destinations.

On the Pittsburg & Lake Erie Ry. the average number of cars entering the Haselton yard daily is 2,434 northbound and 2,418 southbound; at the McKees Rocks yard the numbers are 1,745 and 1,841 respectively. Approximately 90% of these are through cars, destined to points beyond the yards. Approximately 50% of the cars moving through the McKees Rocks yard are in through trains and meet with no detention. At the Haselton yard, the maximum detention is 15 hours and the minimum 5 hours. The approximate detention of all cars (not including bad-order cars) is about 5 hours.

On the Pennsylvania Lines West of Pittsburg, the average number of freight cars entering the Pittsburg yards daily is 6,000, and 4,500 of these (or 75%) are through cars, having destinations beyond Pittsburg. The average time of detention of a through car at the Pitcairn yard, for the period from Aug. 16, 1906, to Jan. 31, 1907, was 10 h. 19 mins. In this yard a considerable amount of prior classification is done, and in consequence the average detention is higher than in other yards where less of this work is done. For instance, in the Hollidaysburg yard a record shows an average of 5 h. 32 mins. In the latest review or audit of the slow-freight movement over the various main line divisions, the proportion of through cars was found to be about 91%. The average detention of through cars passing through the various yards was 7 h. 40 mins., the maximum and minimum in any one yard being 17 h. 3 mins. and 2 h. 20 mins. respectively.

The question of the detention of local cars at their terminal points or destinations is one of great importance as affecting the car efficiency, or the keeping of cars in service, and we have made some special inquiries in regard to this matter. This detention means the time elapsing from the time the loaded car comes off the road and enters the yard, and the time at which the same car is returned empty to the yard from the industry track. On the system of the Pennsylvania Lines West of Pittsburg, the average detention of local cars has been found to be 6.74 days; the maximum and minimum were 7.90 days and 3.66 days respectively. This information, which was obtained at our request, is worked up in the following way: The car record office takes from its records the number and initials of cars leaving a certain terminal on a certain day. It then ascertains from the records the length of time these cars have been in this terminal, and excludes all cars arriving and departing on the day for which the record is taken. This is done in order to exclude the cars which may be passing through the terminal. It will readily be seen that such an audit is a very hard test since it includes every part of the time the car has been in the terminal, including shifting, unloading, reloading and movement. This, it will be noted, is somewhat different from the car service figures, which only include the delay attributable to the consignee.

As already stated, it is a difficult matter to state what is the minimum, maximum and average time for a local car from the time it comes in off the road until it is brought back from the industry track for re-forwarding. At St. Louis there are many cases where a car is received by the Terminal Railroad Association at 4 a. m. and placed at an industry before 7 a. m. This car may be unloaded and pulled out of the industry by 2 p. m. and delivered back to the connection from which it was received by 4 p. m. In such case the car is on the Terminal Railroad Association's tracks only 12 or 13 hours. In the general handling of equipment, however, for industries served by these tracks, the cars are delivered to the Terminal Association in mixed train lots. They must then go to the separating yards and be classified. It may take from 3 to 18 hours before they are pulled off of the classified tracks, and forwarded in train lots to another district, where they must be again reswitched and placed at individual industries. In the second district where the cars go, it may take five or six hours to reclassify the cars and place them at the individual industry. It must be remembered, of course, that consignees are allowed 48 hours free time to unload. After the car is released it may take from 6 to 14 hours to get it back to the connection from which it was received. It is thus evident that while a local car may sometimes be handled in 12 or 13 hours, in other cases it may take four or five days.

While the information given above is of particular interest as showing actual conditions at important points, it must be remembered that the figures cannot be taken to represent conditions in general. For instance, it cannot be intelligently compared with similar information from other roads, since the basis of compilation of the figures is not likely to be same on any two roads. Neither can deductions be drawn, applicable to railways in general, since such generalization would necessarily disregard the details of actual conditions and would, therefore, produce misleading results. However, with this explanation, and for convenience of reference and for comparison with the figures given in our issue of April 4, we tabulate the figures given below.

The Israelites in Egypt struck because they were required to manufacture bricks without straw. From far away Saskatchewan, there comes to us an inquiry for a machine to make bricks with straw, and nothing else. In that wheat raising country there is literally straw to burn and nothing else to burn; and if the straw could be compressed into solid bricks, it would transform what is now a waste product into a valuable fuel.

THE PUBLIC UTILITIES LAW OF NEW YORK.

The most notable step toward Government control of monopolies that has been taken for many years is the enactment of the "Public Service Commissions Bill" by the New York legislature. The bill has been vehemently attacked by the representatives of the corporations affected and by the financial interests; but it passed both houses of the legislature with but a trifling opposition on the final vote, was signed by Gov. Hughes last week, and is to go into effect on July 1.

Is the new law a "radical" measure? The answer to this question will depend very much on the point of view of the one who makes the reply. The man who believes the public utility corporations should be let alone to conduct their business as they see fit, will naturally denounce the law as a piece of rank socialism. The man who favors the policy of municipal and state ownership of natural monopolies, will view the law as a mere makeshift, destined soon to be cast aside for a much more revolutionary plan. But to the man who holds the middle ground—and who we can but believe, represents the great body of intelligent public opinion—this new law stands as a necessary forward step in Governmental evolution. It is necessary, because—to put the case in a nutshell—either the Government must control these public utility corporations, or else they will control the Government.

DETENTION OF FREIGHT CARS IN YARDS.

	Ave. cars per day.		Detentions in yards.		
	No.	Pct.	Max.	Min.	Ave.
P. & L. E. Ry.; Haselton yard	4,852	90	15 days.	5 days.	5 days.
P. & L. E. Ry.; McKees Rocks yard	3,586	50	15 days.	5 days.	5 days.
Penn. Lines West of Pittsburg:					
All yards; through cars	....	91	17 h. 3 m.	2 h. 20 m.	7 h. 40 m.
All yards; local cars	....	9	7.90 days.	3.66 days.	6.74 days.
Pittsburg yards	6,000	75	.....	.....	.....
Pitcairn yard; through cars	....	..	.....	.....	10 h. 19 m.
Hollidaysburg yard; through cars	....	..	.....	.....	5 h. 33 m.
Average for several West and S. W. railways	....	..	10 days.	2 days.	6 days.
Terminal R. R. Assoc., St. Louis:					
Local cars			12 hours to 5 days.		

It may be of interest to see just what this new law—so bitterly condemned by the corporation interests—proposes. We have said the law is a step forward in the public control of corporations; but it is not a long step forward. The railroad commissions of several states have had for years as great powers over railway corporations as the new public service commissions are to exercise in New York. In Massachusetts, State Commissions have been for years exercising control over gas and electric light companies, such as is now to be exercised in New York. New York itself has had a Railroad Commission for nearly a quarter of a century and a Gas and Electricity Commission was created two years ago. Both these Commissions have done valuable work. The new law abolishes both these Commissions and confers their powers on the new Public Service Commission. The New York City Rapid Transit Commission and an anachronism known as the "Inspector of Gas Meters" are also abolished, and their powers and duties are placed upon the new Commissions.

By the terms of the law, the whole state is divided into two districts, the first comprising the city of Greater New York, and the second, all the rest of the state. In each of these districts a "Public Service Commission" of five members is created and is given jurisdiction over all railways, street railways, common carriers, and all works for distributing gas or electricity for light, heat or power. It will be seen that several other important classes of public utility corporations operating under franchises, such as water companies, and telephone companies, are not included. The term "common carrier," however, includes express companies, sleeping car companies, and freight line companies.

Turning now to the powers to be exercised by these Commissions, it should be said that for the most part the requirements are the same as those of existing law. Discrimination between persons and places, false billing, free passes, and similar practises are prohibited as in existing laws. In addition, however, the Commission is given full authority over all the operations of the corporations under it. While the primary responsibility is on the corporations to render good service to the public and charge only reasonable rates, the Commission has full authority to inquire into and compel the remedying of any dereliction in either respect. It is because the bill does go further than any previous measure in clothing the Commissions with power over these public service corporations, that such a measure of opposition from the corporations has been aroused.

It is around the requirement that "all rates shall be reasonable," that future controversies are certain to be waged. No one objects to this provision. Every corporation officer will deny that his company ever charges a rate that is unreasonable. But when we get down to the definition of a reasonable rate, the two sides are far apart. It will be one of the most difficult duties of the new Commissions to frame a definition of a reasonable rate—one which will be accepted alike by the public and by the corporation managers, and which will stand the test of the courts. It is even among the possibilities that the constitutional powers of the new Commissions may be found inadequate for the settlement of this question. It may be necessary to resort to the legislature for the enactment of a law defining in general terms what conditions a reasonable rate charged by a public service corporation shall fulfil.

Quite as important a part of the law as the clauses defining the powers of the Commission are those fixing its make-up. In nearly or quite all previous attempts at state regulation of monopolies, the mistake has been made of creating a regulating body inadequate in numbers and too poorly paid to secure efficient service. What would be thought of a Board of Bank Directors who employed a two-dollar a day laborer to watch a ten-thousand dollar a year cashier and prevent him from making way with the funds? Yet this is on a par with most of the experiments which have been made in regulation of railways by State Commissions.

For the first time now, the State of New York recognizes that the task of controlling the public service companies of the state with their billions of dollars of capital is a task demanding all the energies and time of the highest class of men that can be secured; and it has declared its willingness to pay the market price for such men. Each of the five members of each Commission is to have a salary of $15,000 per annum and his expenses. The contrast between this and all previous attempts at Commission control over corporations is one which the corporations themselves fully appreciate. It ought to be possible to secure for this sum men of as high character and standing as the judges in the courts of law, or those who lead in other professions, or those at the head of private business enterprises.

Of course it goes without saying that men who can be purchased or controlled by influence can nullify the intent of the law to protect the public from extortion, while a demagogue could misuse such a position with resultant disaster to the vast interests dependent on his decisions. But exactly the same thing may be said of the men in executive positions, or in the legislature or on the Bench. The public must trust someone; and there is no reason apparent why the men on the new public service commissions should not be as deserving of trust and public confidence, and as likely to give the corporations as well as the people a square deal as any officers of the legislative, executive or judicial department of Government.

We see absolutely no justification for the outcry against "Government by Commissions" which the corporation defenders are emitting. Chancellor Day of Syracuse University, who is doubtless the most unique representative of the corporations, in his baccalaureate "sermon" on June 9 is quoted as saying:

> The distinction between the executive, judicial, and legislative order is disappearing in a form of oligarchy named "commissions."
>
> The laws are taken out of the hands of Congress and the legislature and put into the hands of commissions, subject to executive appointment and executive pleasure.

The facts are, however, that the delegation of certain Governmental functions to Commissions is an absolutely necessary step in the evolution of Governmental machinery. No legislature and no court can possibly do the work that modern conditions make it necessary for the Government to undertake. A Commission is nothing more than a body of executive officers to whom a particular task is assigned.

Of course there are a few like Chancellor Day, who still hold to the "Laissez faire" theory of government, who would leave the public at the mercy of those who control the monopolies on which modern municipal life and commercial life is dependent, and who argue learnedly that the law of supply and demand is sufficient protection for the people.

The absurdity of this position has been proved over and over again. Every honest and intelligent authority on public questions recognizes that there are to-day only two alternatives, if "government of the people, by the people and for the people is not to perish from the earth." These alternatives are Government control of monopolized industry or Government ownership. It is the former alternative which the State of New York is about to attempt; and every intelligent and patriotic citizen will watch the operation of the new Public Utilities law with hopeful interest.

In conclusion, we may appropriately express the opinion that in the selection of members for the new Commissions, the engineering profession should be adequately represented. These Commissions must investigate and render opinions upon many technical questions in connection with the operation of railways, electric plants, gas plants, etc. It will be of great advantage if the Commissions are not obliged to rely wholly on experts whom they may hire, but have in their own membership men able to form intelligent opinions on any technical matter brought before them. The other necessary elements in the candidates, such as moral and professional standing, fidelity to duty, judicial temperament and broad culture can surely be found among members of the engineering profession as readily as among those engaged in any calling.

LETTERS TO THE EDITOR.

Should an Engineer Furnish His Own Instruments?

Sir: Referring to the letter in your May 30 issue, entitled: "Should a Civil Engineer Furnish His Own Instruments," it seems to me a poor policy on the part of the State to insist on this provision. The instruments furnished by employees must be of many grades, good, bad and indifferent, and the quality of the instrumental work done must vary accordingly. While on some parts of the work this might make little difference, for running base lines and similar work, one would expect trouble from second-hand instruments.

Yours truly,
W. B. Wm. Smith.

New York, June 1, 1907.

Building Department Regulations for Reinforced Concrete.

Sir: In making the statement in a letter published in your issue of May 30, that the Building Department of Philadelphia allowed 300 lbs. on the concrete and 800 lbs. when hooped, the writer owes the department an apology for a careless oversight. It should have been 500 lbs. on the concrete, which could be increased 300 lbs., or to a maximum of 800 lbs., when properly hooped.

The Building Department of St. Paul is allowing for the hooping since tests were made by the Department of Minneapolis. In view of the fact that it is the taxpayers' money that is being expended when an excessive margin of safety is demanded and that they are taking chances when the reverse is true, the move on the part of the City of Minneapolis in equipping its Building Department with facilities for testing specimen columns up to 400,000 lbs. is one which would unquestionably be profitable for cities of that size or larger. The writer does not question that when the various departments are thus equipped the requirements will be more uniform and liberal, and the reinforced-concrete contractor will not feel that because he adopts a type of design that he considers conservative he will be expected to place himself at a disadvantage in competition with other types more favored by rules in effect that are arbitrary rather than based on the actual tested strength of the work.

The writer's criticism was intended rather to call attention to the difference in practice and the disregard by many of the results of actual test data, as exhibited in Marsh's work on "Reinforced Concrete" in dismissing the methods of Hennebique as irrational, which were based on test data, and presenting the Dunn formula for slabs reinforced in two directions as rational without the backing of any test data whatever.

Very respectfully yours,
C. A. P. Turner.

Phoenix Bldg., Minneapolis, Minn., June 3, 1907.

Expansion Joints in Concrete.

Sir: The subject of expansion and contraction in concrete structures, and the means to be taken to prevent them or to counteract their bad effects, is one of great interest to engineers, and the discussion of this subject in recent issues of Engineering News (May 2 and May 9) is very timely.

There are circumstances under which expansion joints in unreinforced walls are effective in preventing cracks even when exposed to extreme changes of temperature. In the South Park System of Chicago there have been built during the last three years a number of plain concrete walls, aggregating over 3,000 lin. ft. in length, of the design shown in the accompanying drawing. They are used for enclosing service yards in various parks throughout the system, and are finished off with tile coping. The pilasters were built up first, with vertical grooves in the sides, 3 ins. deep; into these the walls "tongue" with a slip joint, providing for expansion or contraction without a tendency to overturn the pilasters or to open up a visible crack. Expansion was provided for by setting a hard-wood wedge in the bottom of the groove in the pilaster and raising it from time to time as the wall was built up. As the concrete was mixed quite dry this could be done without the concrete flowing into the space from which the wedge was withdrawn. The movement of the wall in contraction was made easy by placing a strip of paper on either side of the groove to prevent the adherence of the fresh concrete. The pilasters are spaced upon an average 30 ft. apart (never more than 40 ft.), and expansion joints are made in each pilaster.

It will be noted that the curtain walls between pilasters are comparatively thin, 10 ins. in the panels. They are exposed on both sides, so that the temperature through the thickness of the wall changes promptly with

every change in the atmosphere. The heights of the walls vary from 9 to 12 ft., and the foundations in all cases are upon earth, either clay or sand, with no piles beneath. No cracks of any kind, not even hair cracks, have appeared in these walls. The absence of hair cracks may be explained by the fact that the concrete was mixed fairly dry and thoroughly tamped in place without any rich facing mortar and without spading to draw an excess of mortar next the form. The aggregate was a finely crushed limestone (¼-in.). This makes a wall with a uniformly roughened, pitted surface, almost without form marks, which is immensely superior to the average mortar-finished surface.

In building a retaining wall of plain concrete along the edge of an artificial lagoon, the same concrete made of fine crushed limestone mixed rather dry was used for a surfacing material, with expansion joints 50 ft. (or less) apart. No wedges were used in this case to provide an open joint, but the wall was built in sections with vertical bulkheads. When the bulkheads were torn away ready for the next section of wall the end of the completed wall was plastered with clay about ¾-in. thick. A vertical groove was made so that the sections of wall dovetailed into each other. This wall is founded on clay with 6 ft. depth of water in front of it and a fill behind it 4 ft. above the level of the water. It is finished with a balustrade made of molded blocks. No cracks of any kind appear, but there is evidence of contraction and expansion at the joints.

Another example coming within my recent experience is that of a sea-wall in Jackson Park, on the shore of Lake Michigan. A stretch of 1,200 ft. of this wall was built in 1905-1906. It is 12 ft. high, with an 8-ft. base founded on piles cut off 2.5 ft. below average water level. It is finished off with a coping 30 ins. wide and 12 ins. deep. It was built in sections of 50 ft. or less, but no special provision was made for open joints at the ends of the sections. The junctions between the sections provided vertical planes of weakness which were marked on the surface with V-shaped grooves in anticipation of the joints which developed themselves with the shrinkage due to setting. The body of the wall was made of 1 : 3 : 6 concrete, with a mortar surface made by plastering the forms. The coping was made of a much richer concrete than the body of the wall and finished off with a troweled top surface. The result is that there are no cracks in the body of the wall except surface hair cracks and the straight vertical cracks which have opened up in the V grooves mentioned above. But in the coping, in addition to the joints provided every 50 ft., from three to twelve cracks may be seen in every 50-ft. section. Not all of these cracks run clear across the coping, but all appear in the front overhanging edge.

My conclusions from these and other similar examples are as follows:

1. Joints every 50 ft. in heavy walls of homogeneous construction of concrete of ordinary richness, without openings or points of special weakness, are generally sufficient to take care of contraction and expansion.

2. It is not necessary to provide open joints, as planes of weakness become open joints with the shrinkage of setting.

3. If the wall is of light section, or made of concrete of more than ordinary richness, open joints should be provided somewhat closer together than 50 ft. to guard against injury due to expansion as well as contraction.

4. As the rate of expansion or contraction is greater in mortar and rich concrete than in the average (1 : 3 : 6) or leaner concretes, the whole wall should be made of the same proportions if cracks are to be avoided.

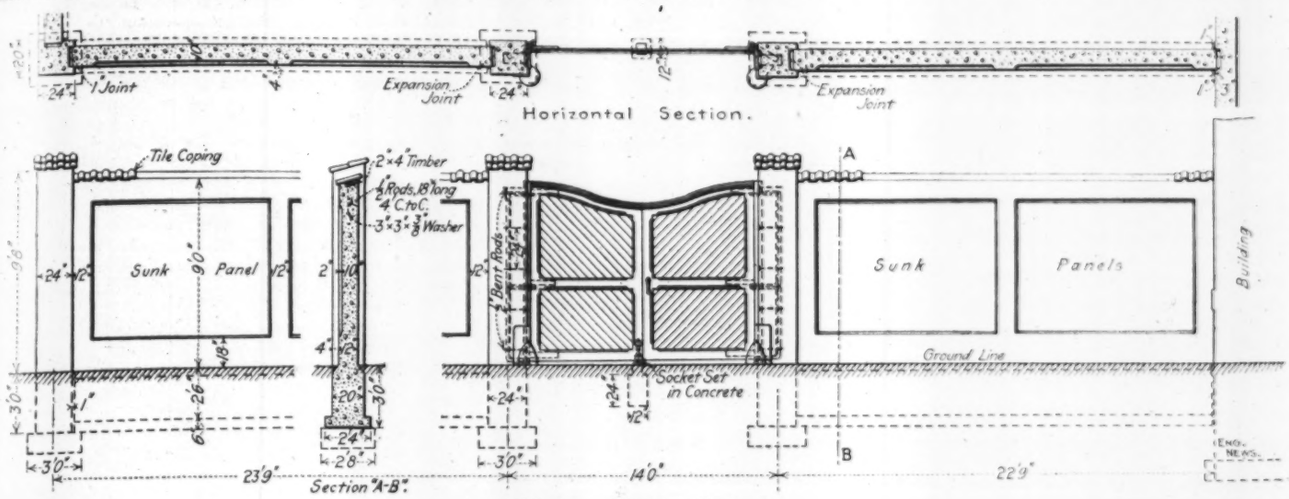
5. Hair cracks in the surface exist only when there is a finishing coat of mortar richer in cement than the body of the wall, either applied as a plaster or drawn to the surface by spading.

6. The different rates of contraction and expansion for concretes of varying richness set up unequal stresses, hence the cracks in the richer portions of the wall, as in the coping mentioned above.

Yours very truly,

Linn White,
Engineer South Park Commissioners.

Chicago, May 14, 1907.



CONCRETE WALL WITH EXPANSION JOINTS; SOUTH PARK SYSTEM, CHICAGO.
Linn White, Chief Engineer.

Notes and Queries.

In our issue of May 30 two typographical errors in numerals crept into the account of the Convention of the American Foundrymen's Association at Philadelphia. The total registration at the convention was 1309, not 1390. Also, out of 1,600 students at Girard College, 980—not 98—are enrolled in the mechanical classes.

NOVEL FEATURES ON THE DREDGE "INDEPENDENT" —BUSH TERMINAL COMPANY, OF NEW YORK.

The 4½ cu. yd. dipper dredge "Independent" belonging to the Bush Terminal Co., of New York, and in service in the extension of that company's piers in South Brooklyn since September, 1906, possesses a number of features of novelty in dredge building and practice. She was built especially for the class of work mentioned.

The hull is 90 ft. long by 38 ft. 2 ins. beam and 12 ft. depth. The main house, 52 × 28 ft., contains the main engine-room, crew's and officers' dining-rooms, kitchen, wash-room and toilet. On the forward upper deck are the operating room and the captain's, engineer's and steward's cabins; on the same deck aft is a 16 × 16 ft. cabin housing eight men. The rooms are all steam-heated.

In the general view, at the top—Fig. 1—is shown one of the departures in construction, in the ball-and-socket joint at the head of the "A" frame—a device which, by equalizing the strains in the two sides of the boom, relieves that member considerably. Details of the castings for this joint are shown in Fig. 2.

The main hoisting engine—of the double-cylinder (16 × 18 ins.) double-drum type—is on the main deck forward. The bed-plate is extended forward between the drums and carries the center bearing, thus insuring by the rigidity so obtained a proper maintenance of pitch line between the crank-shaft pinions and the gearing on the drums. The engine can exert a pull of 25,000 lbs. at a rope speed of 200 ft. per min. The main drums are 29 ins. diameter by 42 ins. face. The distinct features here are the friction drive and the thrust which brings it into engagement. The friction faces have cork insertions, which are used—we are informed—for the first time in dredge work. The frictions are of the standard

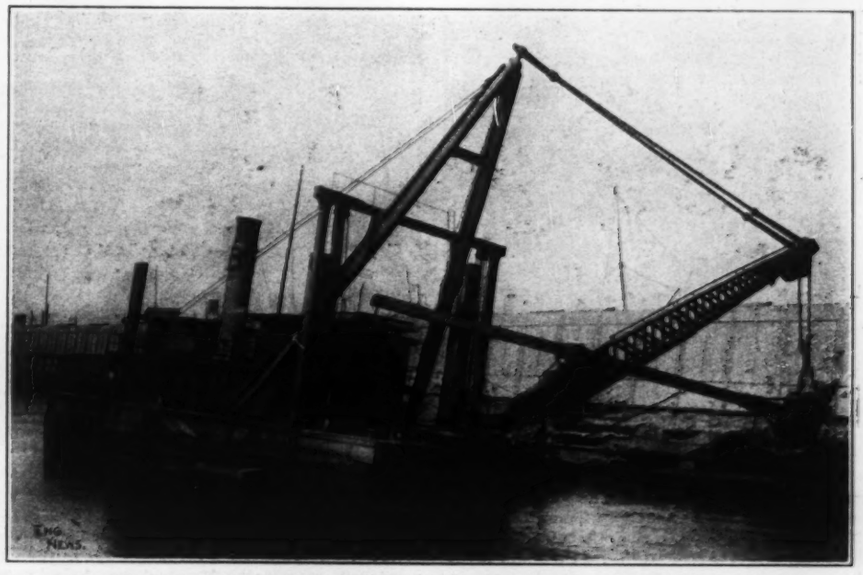


FIG. 1. GENERAL VIEW OF BUSH TERMINAL CO.'S DREDGE "INDEPENDENT," SHOWING BALL AND SOCKET JOINT AT HEAD OF A-FRAME.

Lidgerwood truncated cone type, the male member of hard wood and the female of cast iron. In the male member are bored ¾-in. holes, in which are set corks; the holes are staggered so that the entire rubbing surface of the female member is covered by the corks as the cone revolves. The cork-insert friction faces give about double the usual holding power, and are not affected by grease as ordinary frictions are.

The thrust is transmitted through roller bearings—the largest ever made by the Philadelphia Roller Bearing Co.—the friction being set up by an arrangement of toggle levers shown in Fig. 3; the mechanism is operated by an Osgood steam-grip cylinder, also shown in the cut. The use of roller bearings, instead of the older method of using a slotted shaft and key, with a friction screw inside the shaft bearing against the key, has given excellent results; the bearings are clearly shown in the cut. Both the main drums and the back-haul drum are thus equipped.

The head-sheave bearings on the main boom are considerably shortened over previous practice, and are cast instead of forged. They have demonstrated their efficiency in service under extraordinary strains.

The thrust of the boom is taken up by roller bearings, some of which are shown in the view of the turntable, Fig. 4. The vertical thrust is taken by eight conical rollers and the horizontal thrust by eight cylindrical rollers. These rollers are interchangeable without unshipping the turntable. The brackets carrying the guide-sheaves at the side are cast separate from the main turntable and bolted on, to facilitate repair work in case of breakage.

Fig. 5 shows a view of the interior of the operating room, which is claimed to be the most completely and conveniently equipped room ever placed on a dredge. With the exception of two small auxiliary capstan-engines, all of the operating machinery on the dredge may be controlled by the engineer in the operating room without shifting his position. The functions of the levers are as follows: Right center front, main throttle; left center front, spud-engine throttle; four on starboard side, forward-spud friction, forward-spud brake, after-spud friction and after-spud brake, counting toward stern; four on port side, corresponding port-spud frictions and brakes; foot-or-hand levers in center, port and starboard main-drum frictions. The stool between these last two has its function to perform also, as sitting down upon it operates the back-haul drum friction; thus the operator is enabled to employ one more than the usual number of available manual and pedal functions.

The foregoing covers the essentially novel features of the dredge. Mention may be made of a report-card system successfully employed in keeping a complete record of the loading and unloading of every scow; the cards employed are so arranged that the items are punched in them instead of being written. Other data of interest are: Back-haul drum, 24 ins. diameter by 40 ins. face; fore and after spud drums 10 ins. diameter by 12 ins. face, driven by four friction-drum spud engines without link motion; two capstans are driven by this set of engines through bevel gears, and may be thrown in or out by clutches. The dipper is of the Osgood type—4½ cu. yds. as previously stated—the handle being 16 × 16 in. Oregon fir 58 ft. long, reinforced by 4 angle irons 6 × 6 × ½ ins., riveted through and through. The main hoisting chains are 1¼ ins., the forward-spud chains ¾-in. and the after [illegible] 1⅛ ins.

Parts used have been standardized and duplicated as far as possible—e. g., drums [illegible] size are all duplicates, and shafts, gears, etc., interchangeable, thus minimizing the number of spare parts to be carried. It may be mentioned here that in eight months' operation the only repair made on board was the replacement of a stripped bevel gear driving one of the deck capstans, which was damaged in pulling off a [illegible]unded scow. During that length of time, which included the winter, the "Independent" has handled 168,000 cu. yds of material, of which about 56% was sand, 43% old crib-work, and some rock. She has handled some boulders weighing 10 to 15 tons, and on one occasion got under a boulder which her designer figured at 20 tons—being 15 ft. long; this boulder, which lay across the top of the bucket, was too heavy for the hoisting chains, and auxiliary tackle was used to handle it.

The "Independent" was designed by Mr. W. H. Arnold, M. Am. Soc. C. E., until June 1 Chief Engineer for the Bush Terminal Co., with the cooperation of the engineers of the Lidgerwood Mfg. Co. in matters affecting their work; the operating machinery is entirely the product of the Lidgerwood Mfg. Co. with the exception of the pumps, which were supplied by the W. H. Blake Steam Pump Co. The boiler, 11 ft. diameter by 12 ft. long, 125 lbs. steam pressure, was furnished by Heipershausen Bros., New York.

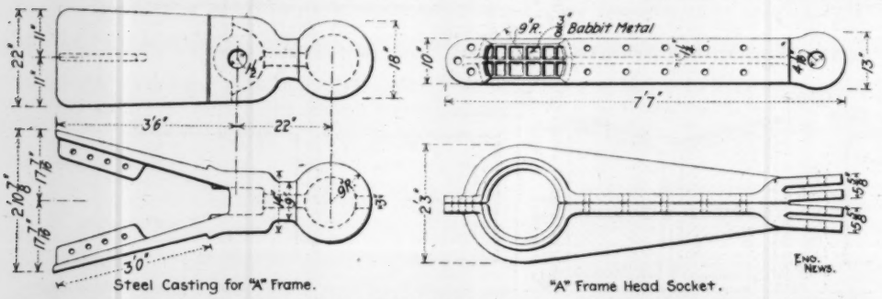


FIG. 2. DETAILS OF BALL AND SOCKET AT HEAD OF A-FRAME, DREDGE "INDEPENDENT."

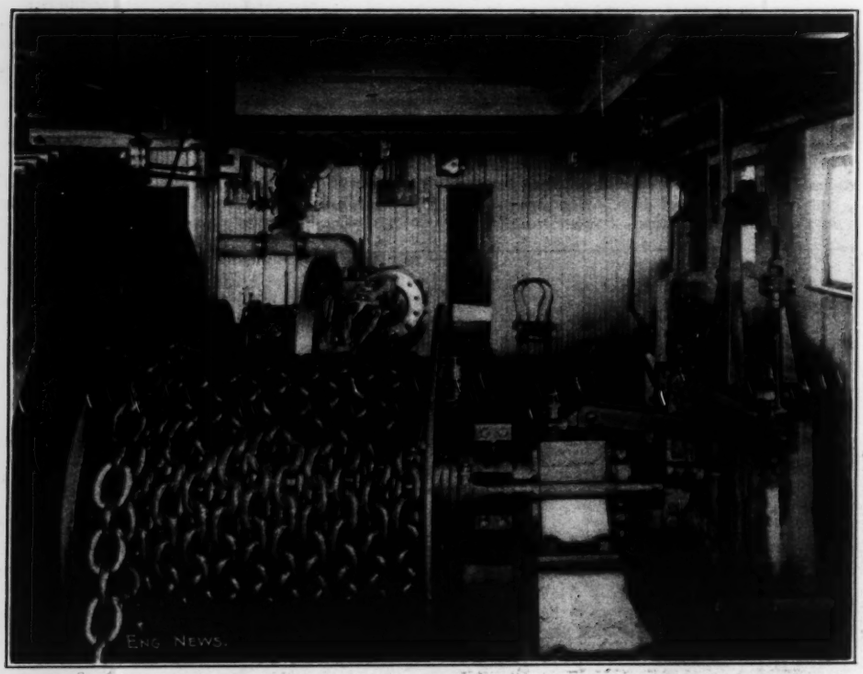


FIG. 3. MAIN HOISTING DRUM, DREDGE "INDEPENDENT," SHOWING ROLLER THRUST FRICTION MECHANISM.

THIRTIETH ANNUAL CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The thirtieth annual convention of the National Electric Light Association was held in Washington, D. C., June 4-7. When the Association was started, in 1877, the electric light was hardly more than an experiment; to-day the numerous variations on the old forms and the invention of new lights are astonishing even to the illuminating engineer. In the 13 years that have elapsed since the Society met before in Washington, its membership has increased from 246 to 1,286 persons, in addition to many member companies.

The Association in its early days attempted to present papers on technical subjects alone. At present, while the technique of electric lighting is not slighted, a very large part of the work done relates to the commercial side of the business. One of the best features of the convention was the magnificent exhibition of the different member companies of the Association.

The convention was remarkably successful, over 1,450 members and guests being registered. Every morning was given up to the hard work of reading papers and discussing and accepting reports, but the program was so large and interesting that many of the papers ran over into the evening sessions, which were intended more especially for the lighter work and viewing the exhibition.

This exhibition occupied the entire space of the large ball-room of the New Willard Hotel, a room some 60 by 250 ft. in area, immediately adjoining the convention hall. It comprised in its numerous booths about all the companies now interested in manufacturing lamps, switches, meters and other appliances used in electric lighting. In addition, many related companies, such as advertising concerns, electric piano-players, electric cooking devices, etc., were represented.

On account of the time taken in the discussion of some points it was found impossible to read in toto all of the papers and reports which had been prepared. As most of these had been printed and were in the hands of members a good many were read in abstract by their authors. A brief summary of most of these papers and reports follows.

PAPERS AND REPORTS.

The first work of the convention after the usual preliminary exercises was the report of the Committee on Progress by Mr. T. C. Martin, of New York. This report comprised some 60 pages of

printed matter and related in detail the growth of the art of electric lighting during the past year. It was in a way an epitome of the larger part of the reports presented by the various committees on other lines of work and covered general statistics of growth, conditions in the foreign trade, new central-station work, rates

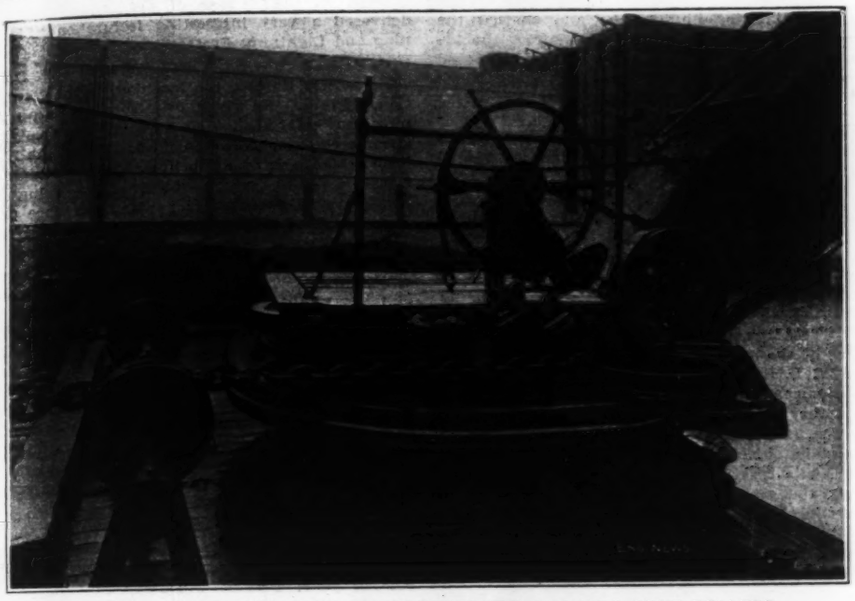


FIG. 4. TURNTABLE, DREDGE "INDEPENDENT," SHOWING CONE ROLLERS.

and regulations, variation of street-lighting methods, transmission and distribution, illuminating engineering, the question of central station employees, developments of arc lighting, and insurance. It is a particularly concise and comprehensive review of the field of the rather new branch of illuminating engineering.

This paper was followed by a paper by Mr. Paul Lüpke, of Pittsburg, on "Accidents," which

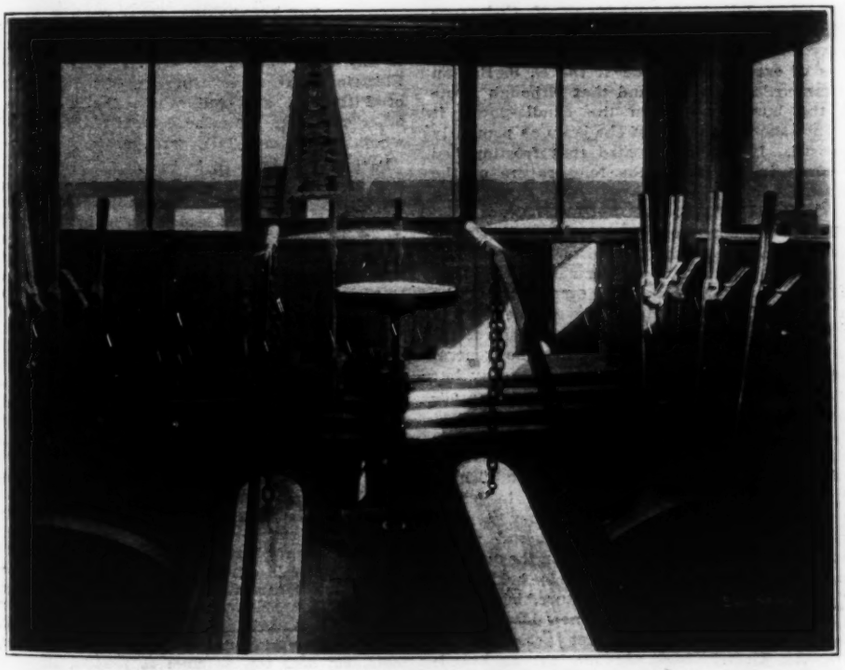


FIG. 5. OPERATING ROOM, DREDGE "INDEPENDENT," SHOWING FACILITY OF CONTROL.
Note "Piano Stool" for Operating Back Haul.

while pertaining to the electric lighting plant is in such pithy and epigrammatic style as to be well worth the time of any engineer whose plant may be thrown out of order by some minor accident. It appears elsewhere in this issue.

POWER FACTOR CORRECTION BY SYNCHRONOUS MOTORS.—This next paper was read by Mr. F. D. Newbury, of Pittsburg, Pa. He said that a synchronous motor running light as a synchronous condenser has a field which practical conditions justify. There are three cases in which this is good practice:

(1) In existing systems where the central station is up against trouble due to low power factor, which can be remedied only by the installation of synchronous condensers. (2) In proposed systems which will have a large inductive load and in which the investment for feeders and transforming apparatus will be a large proportion of the total cost. (3) In proposed systems which will have a large inductive load and in which slow-speed generating units—such as gas-driven units—will be used.

The "Question Box" was next brought before the convention. Heretofore this has been maintained by the Association in the shape of a committee which received all questions of practice and theory and prepared answers for the same, which were published at the annual meeting. This had many disadvantages, particularly that of the lack of value in an answer received so long after the question was put. A resolution was adopted recommending that the incoming Executive Board be advised to appoint a committee of six, to be known as the Bureau of Information, whose duty it should be to answer, on receipt, all legitimate questions; these same questions and answers to be compiled and published as a report at the end of the year.

The "Commercial Development of the Mercury Rectifier," by Mr. Frank Conrad, of Pittsburg, described in detail the theory and construction of the mercury rectifier for converting alternating into direct current.

The questions of rates of charges for electric lighting was brought up in the discussions of the papers by Mr. G. W. Betts, of New York, on "Legal Justification for Differential Rates," and by Mr. G. Semenza, of Milan, Italy, on "Italian Methods of Charging for Electric Current." Mr. Betts held that the discount method of charging, with an increasing discount for increasing monthly bill was perfectly legitimate, and corresponded exactly with the reduction in cost made in ordinary business of a wholesale over a retail transaction. Mr. Semenza presented a charging system in use in Italy which works on a discount basis, but on a sliding scale, for the computing of which a series of variable curves are used. This method is rather lengthy to start, but the curves once drawn, the clerical work in making up the bills is quite simple.

The second day's session was opened with a paper by Mr. George M. Little, of Pittsburg, on "New Developments in Arc Lamps and High-Efficiency Electrodes." This dealt with the so-called magnetite electrodes and of a lamp suitable for burning them. Mr. Little described the method of manufacture and theory of operation of these lamps, together with many of the experiments made upon them to eliminate the various faults found at first. He claimed for them a longer life, a higher efficiency and a better distribution of color of light than in the ordinary arc light.

A NEW STANDARD FOR ARC LAMP RATING.

The legal side of the business of furnishing electric light to municipalities took up the next few hours' time. At the convention held 13 years ago, the very pressing need of some standardized method of designation in the wording of contracts for the sale of electric light led to the adoption of the resolution standardizing the arc lamp which has been in use till this year. The main part of this resolution held that "a 2,000-c. p. arc lamp is one requiring on the average 450 watts for its maintenance, the measurements being made at the lamp terminals."

At first this rating of arc lamps on the basis of energy consumed answered all purposes; that is as long as the open arc was the sole type in use. With the advent of the enclosed arc lamps, however, and of the various metallic filament and flaming arc types, the ratio between light produced and energy expended was so variable that the standard then adopted failed in its purpose.

The necessity for changing these specifications was brought to a head by various recent court decisions, particularly the one at Colorado Springs, where an electric lighting company was forced to make a rebate (see Eng. News, May 2, 1907) because they substituted for the ordinary open arc so-called 2,000-c. p. lamp, using 450 watts, an enclosed alternating arc, using only about 420 watts, but which furnished a markedly better illumination than the former. It was very evident that the latter lamp gave the better light, but on account of the form of the contract, made in the terms of the resolution of 1894, the company was not furnishing efficient service and the court therefore ordered the rate reduced.

The convention therefore adopted a resolution which is to be considered as the basis for a specification on street lighting by all members of the Association. This resolution holds that all ratings for street lighting shall be made in terms of illumination as measured by some standard measuring instrument under certain fixed conditions and not by energy consumed. The resolution reads as follows.

(1) Under ordinary conditions of street arc lighting, with lamps spaced 200 to 800 ft. apart, specifications for street lamps should define the mean illumination thrown by the individual lamp, in position in the street, as

measured at the height of the observer's eye and perpendicular to the rays, at some point not less than 200 ft. nor more than 300 ft. distant, along a level street, from a position immediately below the lamp, with all extraneous light screened off and with no reflection from surrounding objects not forming part of the lamp equipment.*

(2) When using smaller units of light, such as series incandescent lamps spaced shorter distances apart, a correspondingly shorter distance from the lamp should be chosen in measuring the illumination.

(3) The lamp contracted for should give a mean normal illumination at the test point (selected as in Sections 1 and 2) not less than the illumination given by the stationary standard incandescent lamp of 16 candlepower at 1/x of the distance. The said standard incandescent lamp should be a standardized seasoned lamp having a determined candle-power in a fixed direction.

(4) When the lamp tested fluctuates in intensity, a number of observations of the maximum normal illumination should be made at a distance of not less than 200 ft. horizontally from beneath the lamp, and the average of these measurements should be taken as the average maximum illumination. A similar number of observations of the minimum normal illumination should be made, the average of which should be taken as the average minimum illumination. The arithmetical mean of the said average maximum and minimum illuminations should be taken as the mean normal illumination called for in Section 1.†

(5) A reasonable number of lamps covered by the contract should be tested.

(6) For measuring the mean normal illumination of a lamp, comparison with the standard incandescent lamp may be made either with a suitable portable photometer or with a reading distance instrument, such as the so-called "luminometer."

(7) The unobstructed mean normal illumination must not be less at shorter distances than at the point of test.

(8) An approximate list of the mean normal illuminations thrown by street lamps of standard manufacture, at horizontal distances within the 200-300-foot range, hung approximately 20 feet above the level of the observer's eye, will be given in the near future.

In the discussion of this subject the papers by Messrs. E. L. Elliott and Henry Floy on Municipal Contracts were of great service.

Mr. C. D. Wood, Jr., presented a paper on "Electric Heating Without Special Concessions from the Central Station." Mr. Woods said that in most cases electricity is sold for special heating devices, such as electrical cooking, glue pots, soldering, etc., without a special rate, particularly when the current is used, as it is most generally, in small quantities. An interesting cost cited was a cost of $3 a foot for the cutting of steel sheet-piling by electric heating current on the site of the Hoffman House in New York City as against $13.40 per ft. under the old methods of drilling and cutting.

GAS ENGINES IN CENTRAL STATION WORK.

The utility and advantage of the gas engine in electrical generation were quite fully touched on in the convention. Three papers on the subject were read: "The Future of the Gas Engine," by Mr. Lewis Nixon; "Producer Gas Engines for Central Station Work," by Mr. Robert T. Lozier; and "Application of Gas Power to Central Station Work," by Mr. J. R. Bibbins. Mr. Lozier's paper considered first the theory of the gas engine and entered into an extensive discussion of it, per se, without regard to its relation to the work of electric lighting. He treated all classes of gas-driven engines, but especially emphasized the producer gas type. Relative cost sheets were given as between steam and gas power and also the comparative efficiencies of the various gases under the heads of natural gas, illuminating gas, coke-oven gas, producer gas and blast-furnace gas; these five being arranged in order of their efficiencies. Mr. Bibbins' paper took up the use of the gas engine in central station work and reviewed the present status of this use of the engine. The operating costs of several plants already installed were given and also a typical method of computing the cost of building a new plant of this nature.

Mr. Edward A. Norman's paper on "Efficiency of Various Methods of Illumination" took up the study of interior illumination and showed the effect of the various items which affect the intensity and distribution of light in enclosed spaces. Summaries of two interesting tests made in office and drafting rooms were also shown.

"Recent Developments in Protective Apparatus," a paper by Mr. D. B. Rushmore, treated the progress of work in lighting protection both from external and internal causes, the former as caused by atmospheric conditions, the latter having its origin in the generated power. The theory of the action is given in the first part of the paper, and a large number of designs for proper protective apparatus are submitted in the second part.

STEAM TURBINE DEVELOPMENTS.

One of the most interesting papers read was by Mr. W. L. R. Emmet on "Recent Steam Turbine Developments." In it were presented for the first time the results of tests made on a 9,000-KW. turbine unit in Chicago. The paper showed that the main objects sought in the development of the Curtis turbine have been: high steam economy; the use of a small number of rugged parts instead of a very large number of fragile ones; the elimination of all small clearances; the economic recovery of the large energy available in high vacuum, and the production of flat load curves, particularly with reference to high overload capacity. The progress of experimental work and the needs of future improvements were also treated.

In his paper on "Balancers vs. Three-Wire Dynamos," Mr. Budd Frankenfield described several dynamos of the three-wire type that have been devised to replace the Edison unit consisting of two dynamos connected in series, with the neutral wire tapped in at the common point of connection. These three-wire types have not been entirely successful.

Dr. Edward P. Hyde and Mr. F. E. Cody presented a paper on "The Effect of Frosting Incandescent Lamps," which gave the results of a series of experiments made at the U. S. Bureau of Standards. It was found that although frosting the lamp cuts down the candle-power it does not shorten the life of the lamp as popularly supposed. It was also stated that frosting has no effect in increasing the temperature of the filament.

GOVERNMENT REGULATION.

The executive sessions of the convention were taken up chiefly with discussions of municipal ownership and government regulation of public utilities. As is only natural among men who are engaged in the private development of a business which is one of those most often recommended for government ownership, the general sense of the convention was opposed to any but private control of their industry. They were opposed to any government regulating board such as that recently authorized by the Public Utilities Bill in New York State, which has discretionary powers of adjusting and establishing rules by which corporations engaged in public service may be regulated. Rather they were in favor of a government appointed board which should act merely as a jury to pass on the question whether or not the corporation is holding to certain laws fixed by the legislature, but which should have no power to make new laws.

The following committees also presented reports: An Electric Light Accounting; on Standard Rules for Electrical Construction and Operation; on the Fire Hazard of Electricity; on the Present Method of Protection from Lighting; on Electric Heating and Cooking; Freight Classification; on the Grounding of AC Secondary Currents; on Rates and Costs and on Relations Between Manufacturers and Central Stations; in addition to the regular Committees on Membership, Dues, Public Policy, etc. Most of these reports were merely standardizations of sub- jects under their title for the general f the members of the Association to govern n in their work.

One of the pleasant features of the c ntion was the presence of Dr. C. P. Steinmetz, pre- sided at and participated quite fully in dis- cussion on the ratings of arc lamps also delivered a very interesting lecture on ight- ning and Lightning Protection.

COMMERCIAL OR "NEW BUSINES DAY.

The entire time of the last day of the ven- tion, June 7, was given over to what i n in- novation in a technical convention; na y, a Commercial or New Business Day. has been stated, one of the prime objects of As- sociation is the exchange of ideas concer the marketing of the electric power when o pro- duced. The program arranged to carry this end consisted of more than thirty paper vering all branches of the commercial end elec- tric lighting. These papers were limited to five and ten minutes each, and unless expressly al- lowed by the convention the discussion was con- fined to three minutes for each speaker. The subjects covered the Commercial Field; Ques- tions of Policy; Wiring; the Solicitor; Adver- tising; Light; Power, and Heating. The papers were all short and concise, giving without super- fluous detail the opinions of practical men. The interest displayed showed very plainly that many members regarded this branch of the work equally as important as the more technical dis- cussions of the first three days' session.

OFFICERS.

The following officers were elected for the coming year: President, Dudley Farrand, New- ark, N. J.; 1st Vice-President, Alex. Dow, De- troit, Mich.; 2d Vice-President, W. C. L. Eglin, Philadelphia, Pa.; Secretary and Treasurer, W. W. Freeman, Brooklyn, N. Y.; Ass't Secretary and Treasurer, Miss Harriet Billings, New York. The business office of the Association, to which all communications regarding copies of the above- mentioned papers should be sent, is located at the Engineering Societies Building, 29 West 39th St., New York City.

THE PREVENTION OF ACCIDENTS.

The following extracts from a paper presented to the 30th annual convention of the National Electric Light Association by Mr. Paul Lüpke, of Pittsburg, are well worth the attention of other engineers than the central station men for whom it was especially written.

No conditions can well be conceived under which the prevention of accidents is of more importance than in the business of electric lighting. We must meet instantaneously every demand made upon us by any one and all of our consumers, and we must sell instantly all that we manufacture. Every accident advertises itself more thoroughly and effectively than anything could possibly be advertised by the cleverest scheme of the best expert.

Our market reaches no further than the end of our lines; spoil it, and we are undone. If, therefore, any one condition can be said to stand out head and shoulders above all others as contributing to the success of an electric-lighting company, it is the furnishing of continuous and satisfactory service—the freedom from accidents—and to this end our first and best efforts must be directed.

The construction of a central station means something more than the mere mounting and housing of various kinds of apparatus offered by the lowest bidder. Do not leave matters absolutely in the hands of your consulting engineer. He may do violence to local conditions to make them fit his rigid standards and preconceived ideas. Again, do not call too many things mere details and leave them to the draftsman to work out; he may burden your plant with a chronic disease merely because he wanted to catch the 5.10 car.

Provide everything that will help to keep the place clean, but keep out, as much as possible, things that must be kept clean. There is no more unsightly thing than tarnished brass, there is no more unprofitable labor than polishing brass; then why the brass?

And now, as to men. I say get them green whenever that is feasible. The right time to look out for your head fireman is when you hire a coal-passer; for your chief engineer, when you hire an oiler; for your chief electrician, when you hire a machine-wiper. This plan avoids much shifting. Floating help is a most serious hindrance to economy and good service. Any bully can

*The reason for leaving the horizontal distance flexible along the street within the range between 200 and 300 ft. is that a definitely specified distance such as 250 ft. might be unsuitable for the purpose of the measurement.

Within the horizontal distance in excess of 200 ft. the distance correction for the height of the lamp above the observer's eye is ordinarily unimportant.

†(a) When a reading-distance instrument is used for measuring the mean normal illumination at specified horizontal range, the average of a number of maximum distances at which a certain size of print can be distinguished may be called the average maximum distance, and the average of a similar number of minimum distances the average minimum distance. From these, the mean distance at which an illumination is cast normally, sufficient for distinguishing that size of print can be determined. This mean distance must lie within the 200-300 ft. horizontal range specified in Section 1. In most cases the arithmetical mean of the average maximum and average minimum distances may be taken as the said mean distance with an accuracy sufficient for practical purposes. The illumination needed for distinguishing the size of print may be determined for each particular observer from measurements of the reading distance with the standard incandescent lamp referred to in Section 3.

(b) When a portable photometer is used at a fixed horizontal distance, such as 250 ft., the mean normal illumination of a fluctuating lamp may be obtained by taking the average of not less than 50 observations at intervals of not less than one-half minute.

discharge a man, but it takes a sage to hire a better one in his place.

The education of your inside men might with profit include a course in position that brings them into contact with the public. To a switchboard-tender who has a realizing sense of the kicking capacity of several thousand customers voltage variation means more than the trifling deflection of an instrument-pointer. The engineer who knows how long thirty seconds of darkness really are in a crowded store or theatre is most likely to double his watchfulness at critical times.

Nevertheless, in spite of all that may be done to prevent them, accidents happen; but every accident that does happen must be considered as an opportunity for improvement. Experience as a teacher is the highest salaried officer of your company, and you are not worth your hire unless you profit to the full by every lesson she gives you.

Fixing up a thing to be as good as it was before it was broken is merely setting up again the trap in which you have once been caught.

There should be nothing more galling to the superintendent than the consciousness that he does not know why a thing happened. The answer to the question "What caused it?" must be pursued with relentless energy. In the full and complete answer lies the way to salvation.

When you have solved the problem and have conscientiously applied the proper remedy to the case in hand, the next thing to do is to hunt up every other place where the same thing is likely to happen from the same cause and apply the remedy there before the trouble comes. When a thing happens for the first time, you may have the consolation that it is an accident in the true sense of the word, but when it happens the second time you know in your heart that it is really something worse.

The persistent carrying out of this plan will eliminate to a great extent those exciting moments when everybody has to be "on the jump." Remember, the utter absence of the need for hurry is immeasurably preferable to the most brilliant exhibition of it. The man that skips over an accident with the remark, "Oh, that's nothing! Little things like that happen every day; we can't help it!" is a dangerous man to have around.

Complaining about the stupidity of your help but proclaims your own. Repetition may be tiresome. You cannot merely give instructions and then go to bed; you must stay up more than once if you want to see them carried out. Electric lighting is a continuous performance with a vengeance.

PRESIDENT ROOSEVELT ON EMPLOYERS' LIABILITY LEGISLATION.

In our issue of Feb. 14 we discussed the matter of industrial accidents and the reforms needed in Employers' Liability laws to place this country on a par with the industrial nations of Europe, with respect to the safeguarding of workmen's lives and limbs. We referred particularly to President Roosevelt's advanced stand on this subject in his annual message to Congress, in which he declared that the law ought to place the entire "risk of a trade" upon the employer.

In an address at the Jamestown Exposition on June 10, the President returned to this subject and we print below in full that part of his speech relating to industrial accidents:

There is increasing need that the welfare of the children should be effectively safeguarded by governmental action. Such governmental action is merely one inevitable result of the ever-increasing growth of our complex industrialism. Decade by decade, it becomes more and more necessary that, without sacrificing their individual independence, the people of this country shall recognize in more effective form their mutual interdependence, and the duty of safeguarding the interest of each in the ultimate interest of all. We need laws for the control of vast corporations such as were not needed when the individual fortunes were far smaller than at present, and when these fortunes were not combined for business use. In the same way we need to change our attitude toward labor problems from what that attitude was in the days when the great bulk of our people lived in the country with no more complex labor relations than is implied in the connection between the farmer and the hired help.

For example, the great increase in mechanical and manufacturing operations means a corresponding increase in the number of accidents to the wage-workers employed therein, these including both preventable and inevitable accidents. To the ordinary wage-worker's family such a calamity means grim hardship. As the work is done for the employer, and therefore ultimately for the public, it is a bitter injustice that it should be the wage-worker himself and his wife and children who bear the whole penalty. Legislation should be had, alike from the nation and from the states, not only to guard against the needless multiplication of these accidents, but to relieve the financial suffering due to them.

Last winter Congress passed a safety appliance law which marked a long stride in the right direction. But there should be additional legislation to secure pecuniary compensation to workmen suffering from accidents, and, when they are killed, to their families. At present both in the sphere covered by national legislation, and in the sphere covered by state legislation, the law in too many cases leaves the financial burden of industrial accidents to be borne by the injured workmen and their families; and a workman who suffers from an accident either has no case at all for redress or else must undertake a suit for damages against his employer.

The present practice is based on the view announced nearly seventy years ago, that "principles of justice and good sense demand that a workman shall take upon himself all the ordinary risks of his occupation." In my view, principles of justice and good sense demand the very reverse of this view, which experience has proved to be unsound and productive of widespread suffering.

It is neither just, expedient, nor humane, it is revolting to judgment and sentiment alike, that the financial burden of accidents occurring because of the necessary exigencies of their daily occupation should be thrust upon those sufferers who are least able to bear it, and that such remedy as is theirs should only be obtained by litigation which now burdens our courts.

As a matter of fact, there is no sound economic reason for distinction between accidents caused by negligence and those which are unavoidable, and the law should be such that the payment of those accidents will become automatic instead of being a matter for a lawsuit. Workmen should receive a certain definite and limited compensation for all accidents in industry, irrespective of negligence.

When the employer, the agent of the public, on his own responsibility and for his own profit, in the business of serving the public starts in motion agencies which create risks for others, he should take all the ordinary and extraordinary risks involved; and though the burden will at the moment be his, it will ultimately be assumed, as it ought to be, by the general public.

Only in this way can the shock of the accident be diffused, for it will be transferred from employer to consumer, for whose benefit all industries are carried on. From every standpoint the change would be a benefit. The community at large should share the burden as well as the benefits of industry. Employers would thereby gain a desirable certainty of obligation and get rid of litigation to determine it. The workman and the workman's family would be relieved from a crushing load.

The national government should be a model employer. It should demand the highest quality of service from its employees and should care for them properly in return. Congress should adopt legislation providing limited but definite compensation for accidents to all workmen within the scope of the Federal power, including employees in navy yards and arsenals. Similar legislation should follow throughout the states. The old and inadequate remedy of suit for negligence would then gradually disappear.

Such a policy would mean that with increased responsibility of the employer would come increased care, and accidents would be reduced in number. The temporary burden involved will not hamper our industries. Long experience of compensation laws in other countries has demonstrated their benefit. What we advocate is only a simple measure of justice, only one step toward the goal of securing, so far as human wisdom can secure, fair and equitable treatment for each and every one.

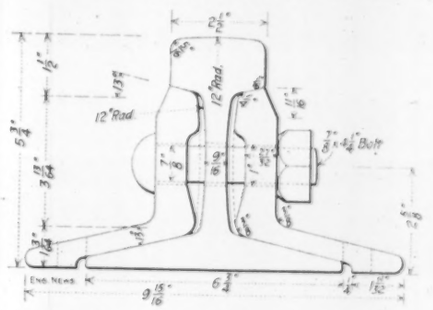
As a corollary to the above let me point out the extreme unwisdom of the railway companies in fighting the constitutionality of the national employers' liability law. No law is more emphatically needed, and it must be kept on the statute books in drastic and thoroughgoing form.

The railroads are prompt to demand the interference and to claim the protection of the Federal courts in times of riot and disorder; and in turn the Federal Government should see to it that they are not permitted successfully to plead that they are under the Federal law when thereby their own rights can be protected, but outside of it when it is invoked against them in behalf of the rights of others.

If it is proper for the Federal courts to issue injunctions in behalf of railroads, it is proper that railroads should be held to a strict liability for accidents occurring to their employees. There should be the plainest and most unequivocable additional statement, by enactment of Congress, to the effect that railroad employees are entitled to receive damages for any accident that comes to them as an incident of the performance of their duties, and the law should be such that it will be impossible for the railroads successfully to fight it without thereby forfeiting all right to the protection of the Federal Government under any circumstances. In the same way there should be rigid Federal legislation to minimize all railway accidents.

EXPERIENCE WITH WIDE-BASE RAILS ON THE ATCHISON, TOPEKA & SANTA FE RAILWAY.

The wear and cutting of ties by rails is one of the principal troubles in regard to the life and cost of ties and the work of track maintenance, and the suggestion has been made many times that the width of rail base should be increased in order to give a larger bearing surface upon the ties. The difficulties of rolling are increased, however, and it is also more difficult to produce wide-base rails of good quality. In order to roll the wide thin flanges while still at a sufficiently high temperature, the rails have to make the finishing passes with the mass of metal in the head at too high a temperature for the production of steel of good wearing properties. It is evident also that at the unsupported parts of the rail (between the ties) the increased width of



Wide Base 101-lb. Rail; Atchison, Topeka & Santa Fe Ry.

base is of little or no value. In view of these conditions it is generally recognized that it is better and more economical to use a rail section in which the width does not exceed the height, and to protect the ties by means of steel or wooden tie-plates.

An interesting experiment with wide-base rails has been made on the Atchison, Topeka & Santa Fe Ry. System, with results that sustain the statements made above. The rail, which is shown in the accompanying cut, is 5¾ ins. high and 6¾ ins. wide in the base, with a weight of 101 lbs. per yd. The form of the head is that of the 85-lb. Am. Soc. C. E. section. This rail is in use on about five miles of track between Ortiz and Cerrillos, N. M., where there is a grade of 1.43%. The rail was designed with the idea of giving a larger bearing upon the ties, and using it without tie-plates. The rail was not easy to roll, however, and the mills experienced great difficulty with it. The results are said to have been satisfactory as far as the effect upon the ties was concerned, but it has been found that the rails break very readily in the base. We are informed that under these conditions it is not probable that any additional orders will be placed for this rail section.

The rail joints have 26-in. splice bars, with four ⅞-in. bolts spaced 5 ins. c. to c. These bars weigh about 75 lbs. per pair.

A NEW PARALLEL RULER.

Efforts are being continually made to reduce to a minimum the purely mechanical mental and physical processes by which a draftsman reproduces on paper what he has in his mind. The less time he has to bother with the details of T-square, ruling pen or drawing board the better will be his concentration on the work in hand. The figure given herewith is from a photograph of a new drafting machine which is designed with this end in view. It was invented by Mr. Duane J. Kelsey, 77 Livingston St., New Haven, Conn., and is called the Economic Drafting Rig.

The details of its construction are very readily seen from the half-tone. The frame is made to fit on an ordinary drawing board, and is extremely light so that it is easily portable and yet is stiff enough to ensure a steadiness and rigidity in the hanging straight edge. This straight edge is flexible enough to accommodate itself to the minor inequalities in the drawing board. The whole swinging apparatus is very

sensitive to the touch and can be readily moved with but slight pressure, but its bearings are made stiff enough so that it will stay in any position to which it is moved. Among additional good points claimed for the rig are the convenient shelf for tools and the provision made for a paper roll on the side, so that in long tracings the paper need not be cut. The tool shown

THE ECONOMIC DRAFTING RIG.
Duane J. Kelsey, New Haven, Conn., Inventor.

lying on the board is a combination square and protractor which accompanies the rig.

The machines are made at present only to order, in sizes for a 31 × 42-in. and for a 23 × 31-in. board. The prices are $15 and $12 respectively, not including the combination square and protractor.

A DEVICE FOR BENDING REINFORCED RODS.

We reproduce, in the accompanying figures, drawings of a bending device for reinforcing bars which has been invented by Mr. R. S. Hunt, of Huntington, W. Va. Fig. 1 shows the bending tool and Fig. 2 is an isometric view of the method by which the rod is bent.

A timber 10 or 12 ins. square is mounted on posts some 40 ins. above the ground and heavily braced (Fig. 2). Along one side of the top face of this main timber is nailed a 2 × 4-in. strip terminating about 1 ft. from the end of the 12 × 12 and with the 4-in. face horizontal. Directly opposite the end of the 2 × 4, a 2-in. pipe is driven

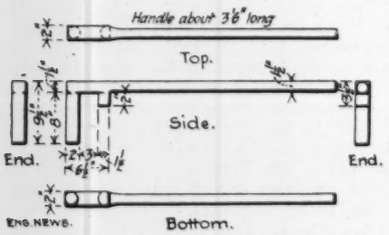


Fig. 1. Tool for Bending Reinforcing Rods.

into the upper face of the large timber, projecting 2 ins. above the face. This pipe is placed at such a distance from the inner edge of the 2 × 4 that when the pintle A of the bender (Fig. 1) is fitted into the pipe the inner edge of the lug B is just flush with a 2 × ¼-in. iron strap fastened along the inner 2-in. face of the 2 × 4-in. wooden strip, and as the pipe projects 2 ins. above the timber the bottom of the lug B is flat on the top face of the timber. The rod to be bent is then put through the 3-in. opening between A and B and with a reaction along the ¼-in. iron strip on the 2 × 4 is readily bent by turning the bender.

Washers may be slipped over the pipe to reduce the distance between the pipe and the ¼-in. strap so that the bars to be bent will have a better fit in the opening. It is advisable, however, to have the space at least 1 in. wider than the thickness of the rod or bar. The principal fault with the device at first was the tendency of the bender to override the bar to be bent. This has been remedied in several ways in different instances. In one case a rounded recess was made in the face of lug B into which the rods fitted and were thus firmly held. In another a steel plate was fastened to the top face of the timber and provided with a grooved slot in which a projection on B engaged. In still another plant the pintle A was made to go clear through the main timber and held on the lower side with a washer and pin; B was made about 1 in. in diameter and a 4-in. wheel fastened to

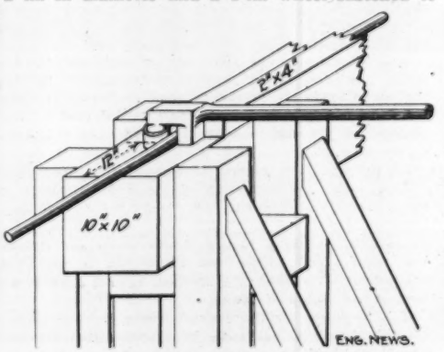


Fig. 2. Stand for Rod-Bending Device.

it. Friction was thus reduced and the bender prevented from jumping the bar. In all cases the pintle A must fit closely into the pipe or it will climb up.

The size bender illustrated in Fig. 1 has been used to bend as high as 1¼-in. sq. rods. One man can bend anything below ⅛-in. in diameter, three men are needed for 1-in. rods, and four men for sizes above 1 in. A pipe can be slipped over the handle for greater leverage in the latter cases.

We are indebted for this information and drawings to Mr. Ernest McCullough, Chicago, Ill.

MATERIALS FOR THE CONTROL OF SUPERHEATED STEAM.*

By M. W. KELLOGG.†

Since the introduction of superheated steam as a large factor in economy in stationary power plant use the question of what type of material is best for the piping to control of the resulting high temperatures has caused a great deal of investigation and interest. In the following discussion of materials, some reasons will be given which explain the results of experience and test, and other facts which we have accumulated from reliable sources will be shown. This article treats particularly of what might be called in a general way Piping Systems, which systems are made up of pipe, fittings, valves, and the necessary details connected therewith, such as joints, gaskets, etc., and are taken up separately.

PIPE.—There can be little question as to the matter of pipe except quality. Of course, welded wrought-iron or steel pipe is successful, but the difference in the quality of pipe under different conditions is very material. As in nearly all instances in a superheated steam station the old-fashioned screwed joint is not satisfactory, it is necessary to do what is termed "work" the pipe—that is, weld, Van Stone, etc.—to make either a welded, Van Stone or other joint of the same general description. Fig. 1 shows what is known as a Van Stone joint.

For this work, the pipe made from open hearth steel is a great deal the best for manufacturing reasons, because it can be properly "worked," there being less carbon, and the quality is much more uniform. Bessemer steel pipe will very often act in a satisfactory manner, but one is never sure that Bessemer will run even and, therefore, troubles may result. It is practically impossible to "work" wrought-iron pipe. In making a Van Stone joint the pipe is nearly sure to split very badly, not only at the weld but all around its outer circumference.

Nearly opposite qualities from those used for getting good results from "working" pipe are required for threading. A good quality of wrought iron will cut and thread more easily with standard pipe machines and standard dies than a steel pipe, and a Bessemer steel pipe will thread much more easily with standard dies than open-hearth. A great many manufacturers have difficulties in threading open-hearth steel pipe, for the reason that they set the dies exactly the same as if they were cutting other qualities. This causes ripping of threads, etc. The die in a pipe machine should be set at a greater angle with the radius of the pipe passing through the point of contact of the die for soft steel than it would be for other kinds, and this in itself will very often eliminate great troubles in this line. The question of lubrication, etc., is also important in this particular.

The ordinary commercial pipe will stand more pressure than the average person believes. A standard 1-in. welded pipe will usually not break under 1,000 lbs. per sq. in. hydraulic pressure. Full-weight pipe I believe to be perfectly suitable for any temperature and any working pressure up to 225 or 250 lbs. as long as it is not thinned at any point by cutting and threading.

FITTINGS.—The designs of fittings as generally manufactured for the different purposes are, in a general way, very satisfactory, with the one exception that very few manufacturers on their standard articles include what is known as the long fillet between the body of the fitting and the flange. This is a very desirable point, due to the fact that at this place there is the greatest strain from shrinkage in the molds, which also tends to develop porous spots. Most large users of this type of material have learned this thoroughly, and design their fittings specially, the chief difference in their design from that of the general manufacturer merely covering this point. The quality of the material in fittings, however, is a very important thing in connection with superheated steam.

The latest practice is to do away with fittings entirely on high pressure steam lines and put what are known as nozzles on the piping itself. This is accomplished by welding wrought steel pipe on the side of another section, so as to accomplish the same result as a fitting. In this way rolled or cast steel flanges and a Van Stone or welded joint can be used. This method has three distinct advantages, to wit:

The quality of the metal used, for reasons explained hereafter when the subject of the effect of heat on metals is taken up.
Lightening the entire work.
Doing away with a great many joints.

As a general average, at least 50% of the joints can be left out, and sometimes this proportion runs up as high

*A paper presented at the Indianapolis meeting of the American Society of Mechanical Engineers, May 28-31, 1907.

†M. W. Kellogg & Co., 143 Liberty St., N. Y. City.

as 60 or 75%, according to the layout of the system. If this method is employed, substantial welds must be made, not only to stand the pressures required but also the strains; this is accomplished successfully in Germany, England, and the United States.

VALVES.—It is important to have a good design of valve. I believe that nearly any of the designs made by the good manufacturers are entirely suitable, such as a broken or solid wedge valve of the ordinary type, under

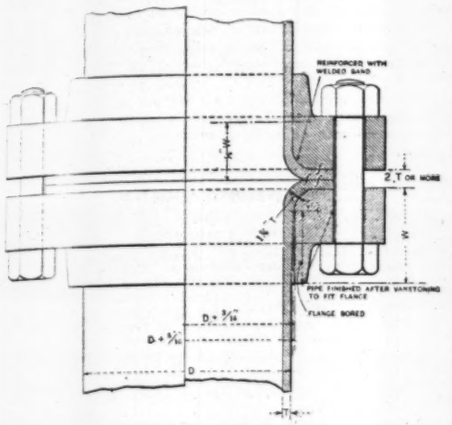


Fig. 1. Van Stone Pipe Joint.

the condition that all machine work is done thoroughly and the quality of metal used is satisfactory for the purpose intended.

It may be interesting to note here the effect of a large range of temperatures on a short piece of steel. By calculation, a piece of steel 6 ins. long, heated 500° will expand 0.019-in. This figure is put down to show how variations in the coefficient of expansion of metals by heat have a large effect on the permanency of a valve staying tight, and it can readily be seen that a small proportion of the distance given is sufficient to cause trouble.

METALS.—I find that different authorities vary slightly in their statement as to what temperatures different metals will stand with good results. German authorities state that cast iron should not be used above 480° F. Other authorities allow us to go as high as 575° F. Above these temperatures in cast iron the limit of elasticity is reached with a pressure varying from 140 to 175 lbs. Under such conditions the material is strained and does not resume its former shape, and eventually shows surface cracks, which continue to grow until it lets go. These temperatures and pressures also lead in time to a shrinkage of all parts, and to a structural alteration of the metal, which results in leakages in valves at the seatings. Therefore, it would seem that iron castings are unsuitable for both fittings and valves to be used in any superheated steam work. While they may last for some time, after a few years' use the metal becomes very weak and some cast iron has reached the point in weakness where if it were merely tapped lightly with a hammer it would break into pieces.

The only adaptable metal I believe to be cast steel. The results of tests by Bach on this metal for the effect of temperature are such that a 572° F. the reduction in breaking strength only amounts to about 1.1% and at 752° F. to about 7.8%. Therefore it seems that this metal is practically capable of withstanding all pressures and temperatures up to at least 800° F. without showing any appreciable weakness.

The influence of high temperatures on bronze, etc., is very material. At ordinary temperatures bronze has a breaking strength of about 34,100 lbs. per sq. in. and an elongation of 36%. At 572° F. the breaking strength falls to about 19,500 lbs. per sq. in. and the elongation to 11.5%. At 662° F., which is quite a common temperature as it leaves the superheaters, the breaking strength of bronze only amounts to 12,200 lbs. per sq. in. and the elongation at the breaking point is only approximately 1¾%. This seems to eliminate entirely brass or bronze of ordinary composition for use with highly superheated steam.

The effect of temperature on nickel is very similar to that on cast steel and in consequence this material is very suitable for use in connection with highly superheated steam. Bach recommends that bronze alloys be done away with for use on steam lines above a temperature of about 390° F. Even neglecting the special quality of nickel seatings, on account of the great toughness of this metal and the methods which can be used for securing rings of this substance to the valves and conical surfaces, it has the special advantage of having the coefficient of contraction and expansion with temperature almost exactly the same as that of cast steel, so that no slackness of the rings occurs and the valves remain absolutely steam tight. There are instances in which valves constructed with nickel seatings have been satisfactorily used with steam temperatures up as high as 932° F.

Seats, discs, and bushings made of brass or plain bronze do not retain their shape.

For spindles on superheated steam work I strongly recommend nickel steel, which holds its shape and does not deteriorate with high temperatures.

Seatings in valves should not only be screwed in but also pinned in addition, using a fine thread which is very long, to give a tight joint. Seats should also have a flange on the top that makes a joint with the body when screwed down, which prevents the tendency to leak through.

JOINTS.—I think it is generally acknowledged that the old-fashioned screwed joint, no matter how well made, would not be suitable for superheated steam work. This leaves for discussion two general types, viz.: welded joints and Van Stone or Climax joints; that is, any joint where the pipe is turned over the face of the flanges.

In welding a flange on a piece of pipe, great care must be taken to see that the weld is perfect because of the unequal thicknesses of the metals to be so welded. If the weld is thoroughly made, this type of joint is very good, although for erection purposes, due to the fact that the flanges cannot swivel, it does not equal the turned-over joint as mentioned above. The manufacturing expenses in making a welded joint are also much more for the same type of work accomplished, on account of the necessity of doing all finishing work after all rough work, such as welding and bending, has been completed. Therefore, the cost of welded joints is greater, not only for the work done but because of the increased expense in finishing on account of the necessity of employing methods different from those where the flanges, etc., were all finished before the joints were made, as is possible on the turned-over joint mentioned above.

In regard to the turned over or Van Stone point, the quality of its manufacture seems to us the most important feature. This joint can be made in a careless way where the pipe is in no way thickened up and only faced on the front. A joint of this kind does not give good results.

The writer believes, however, if this joint is properly made it is equal to the welded joint as a manufactured article and superior to the welded joint as an article for erection. To have this type well made, the pipe on the end should be thickened up in an amount sufficient so that after the joint is turned over there will be enough metal left to face the turned-over portion on the front, on the outer edge, and on the back. We, of course, take for granted that the flanges are finished on the front. After the work above mentioned is done, the pipe should be as thick on the turned-over portion as the original thickness, or very close to it. Increasing the thickness of the pipe on the end before going through the operation is done in several ways. In a general way, I consider any of the methods satisfactory. The point made of facing the turned-over portion of the pipe on the back is an exceedingly important one, much more so than most people seem to realize. I have known instances where it has been found impossible to make a ground joint, for no other reason.

In reference to making up a joint, I believe that the face of all flanges or pipe where a joint should be made ought to be given a fine tool finish and have the face level, and then use a gasket of some description. A perfectly made ground joint is a good thing but it is very expensive, and it is hard to get the average contractor to furnish it in a perfectly workmanlike manner. Also, after it is so done, it is liable not to stay tight, on account of the tremendous expansion and contraction causing such strains that the joints are liable to open up, particularly when the pressure is taken off the plant. The simple expansion and contraction on the bolts that make up a joint would cause this.

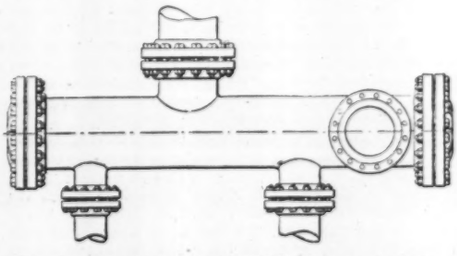


Fig. 2. Example of Welded Pipe Connections Replacing Cast Fittings.

GASKETS.—There are large numbers of gaskets manufactured of all types and descriptions. It is very hard to take up this subject and be fair to each of the manufacturers, for the reason that practically no one can and has had experience with every type made to judge for himself, and hearsay would lead us to suppose that all of them are at one time perfect and at other times useless. I have used a great many different types of gaskets, however, and have obtained the best results with a corrugated soft Swedish steel gasket with "Smooth-on" applied, and with the McKim gasket, which is of copper or bronze surrounding asbestos. The ordinary corrugated copper gasket is a very popular make and has been used a great deal. On superheated steam usually sad results follow. There seems to be some peculiar action that causes this, as on superheated steam lines a corrugated copper gasket will in time pit out in some part of the flange nearly through the entire gasket. I have heard a great many reasons given for the cause, such as electrical action, disintegration, etc.

The wear of a gasket depends largely on the method of pulling up bolts on flanges. In fact I believe that a great many troubles have occurred, because of imperfect erection. If joints are pulled up entirely on one side and left loose on the other, and then taken up on that side, trouble with the gasket is almost certain. The bolts should be taken up gradually all around the flange. The experience of the erecting crews on high class superheated steam lines is an exceedingly important thing. The average steam fitter is not suited to this type of work. He has had experience with lower pressures and less important tasks and after a piece of work is erected by him it is customary to find a great many leaks which are usually only eradicated after the whole joint has been broken and properly repaired. All these troubles can be eliminated by using only steam fitters experienced in the type of work under consideration.

A SCAFFOLD COLLAPSED on June 7, on the new building under construction for Procter & Gamble, at Mariner's Harbor, Staten Island. Ten ironworkers were thrown to the ground, one being killed and the rest more or less seriously injured.

A TRAINLOAD OF MOLTEN METAL at Birmingham, Ala., was run into by a street car at 1:30 A. M. June 5, the street car being set on fire and destroyed. A press dispatch reports several persons badly burned.

ANOTHER ATTEMPT TO WRECK a Union Pacific train, according to officials of the road, was discovered and frustrated near Los Angeles, Cal., on June 7; the attempt was made not far from the scene of the recent deliberate derailment, the wrecker having—it is alleged—tied a heavy log chain across the rails.

TWO KILLED, ELEVEN INJURED is the result of a wreck on the Wabash R. R., near Hickory, Pa., on June 7. The Toledo Express, west-bound, ran into a coal train on a siding, telescoping the smoker and a Pullman; the responsibility was laid upon the flagman of the coal train, who disappeared after the crash.

A CARLOAD OF DYNAMITE blew up at Reddick, Ill., on June 4, killing three men and injuring ten others. The car was in the middle of a long freight-train on the Chicago & Indiana Southern R. R., near the Reddick station; the train was running, when a tank car filled with gasoline left the track and carried with it two other cars, one of which contained the dynamite. The gasoline car took fire—it is reported from a hot box—and the flames spread to the other cars. The explosion of the dynamite wrecked the depot and a number of other cars, shattered most of the windows in Reddick, and was audible at Momence—32 miles away.

A TRAIN DERAILED on June 5 on the Southern Ry., at Black Branch—about three miles from Lebanon, Tenn.—according to press reports, injured 57 out of 60 passengers on board. The train, running at a speed between 20 and 30 miles an hour, left the rails, and two passenger coaches and the mail and baggage cars went over an embankment.

THE PATENT OFFICE FORCE, according to a correspondent of the New York "Tribune," has become reduced in the last six months by the resignation of two chief examiners, four principal and fourteen assistant examiners, as the result of the failure of the last Congress to grant an increase of pay. Private corporations are willing to pay the desired amounts for men with experience in the Patent Office.

The vacant positions are filled by Civil Service examinations, but competent men are not attracted by the salaries. Out of 135 applicants in the last two examinations only 17 qualified.

POWER FROM NIAGARA FALLS is to be distributed through portions of the province of Ontario, Canada. The Hydro-Electric Power Commission has contracted with the Ontario Power Co., of Niagara Falls, to supply 25,000 HP. at $10.40 per HP. year for 24-hour service. The plans of the Commission concerning transmission and distribution systems are not sufficiently advanced so that authentic information can be given.

Newspaper reports, however, repeatedly affirm that the Commission will build the transmission systems, while the various municipalities will have to construct the local

substations and distribution systems. Sixteen cities are mentioned as those to receive the current contracted for with the Ontario Power Co. The number includes the larger places, such as Toronto, Hamilton, London, Brandford, Stratford and Guelph. The cost of power delivered at the distribution circuits of these cities is estimated at $15 to $25 per HP. per year for 24-hour service.

By the terms of the contract between the Commission and the Ontario Power Co., the power may be increased by amounts of 1,000 to 8,000 HP. on 30 days' notice, up to 75,000 HP. It may be increased to 100,000 HP. in amounts of 1,000 or more by nine months' notice. The power ordered is to be available at all times. When the amount supplied is over 25,000 HP. the amounts over are to be paid for at a rate of $10 per HP. year.

THE CANADIAN TRANSMISSION LINES, for the power service inaugurated by the Hydro-Electric Power Commission of Ontario, are being surveyed. The first party has been started at Niagara Falls and will run the preliminary line to Hamilton.

GOVERNMENT TESTS OF WEST VIRGINIA COAL are treated in the report of the Geological Survey, issued in May. It is shown that coal from this region has a particular value for producer gas power. For the production of one E. HP.-hr various samples showed, under test, required amounts of 1.29, 1.40, 1.46, 1.50, 1.57 and 1.78. Samples of the same coals tested in a steam plant required respectively 3.62, 3.46, 3.55, 3.53, 3.90, 3.63 lbs. per E. HP.-hr.

PERSONALS.

Mr. E. W. Ralph has been made General Superintendent of the Boston-Ely Development Co., Kimberley, Nev.

Mr. Geo. H. Phillips has been appointed Superintendent of the New York & Ottawa Ry., to succeed S. F. Remish.

Mr. Wm. S. Austin, M. Am. Soc. M. E., has been appointed Mechanical Engineer for Westinghouse, Church, Kerr & Co.

Mr. W. A. Christian has been appointed Assistant Engineer of the Chicago Great Western Ry., with headquarters at St. Paul.

Mr. Paul Alexander Blackwell, Assoc. M. Am. Soc. C. E., has been appointed Assistant Engineer of the Virginia Bridge & Iron Co.

Mr. John Nicholson has been appointed Superintendent of Motive Power for the St. Louis, Brownville & Mexico R. R., to succeed Mr. H. H. Kendall.

Mr. Delmar P. Ross has been promoted from General Foreman to Master Car Builder for the Michigan Central R. R. He has served that road for 22 years.

Mr. W. E. Bogart, Chief Engineer of the Wichita Valley Ry., has resigned to accept a position with the Kansas City, Mexico & Orient Ry., at Stamford, Tex.

Mr. S. B. Marshall has been appointed Assistant General Manager of the Dunbar Furnace at Dunbar, Pa. He was formerly the Pittsburg Manager for L. & R. Wister & Co.

Dr. A. P. Low, Director of the Geological Survey of Canada, was recently appointed Deputy Minister of Mines in the recently organized Canadian Department of Mines.

Mr. Wm. Graham, Assistant Engineer of Bridges and Buildings of the Baltimore & Ohio R. R., has resigned. Mr. W. S. Bruton, Chief Bridge Draftsman, succeeds him.

Mr. Clifford G. Dennis has resigned as manager of the Marfa and Mariposa mines, Terlingua, Tex. He will assume a similar position with the Colonial Mining Co., of Ehrenburg, Ariz.

Mr. J. E. Moore, Electrical Engineer for the city of Davenport, Iowa, has resigned that position in order to join the engineering staff of the Arnold Co., engineers and contractors, Chicago.

Mr. C. A. Herbert has been appointed General Superintendent of the mines of the Chicago, Wilmington & Vermillion Coal Co., to succeed Mr. R. H. Zoller. Mr. Herbert has been Chief Engineer for the company.

Mr. Alex. A. Shane, of Toledo, Superintendent of Bridges and Buildings for the Toledo, St. Louis & Western Ry., has resigned. Mr. C. L. Kinney, Chief Civil Engineer, has been named as Acting Superintendent to succeed Mr. Shane.

Mr. J. S. Wilbraham, President of the Wilbraham-Green Blower Co., of Philadelphia, has resigned on account of ill health. Mr. E. A. Moore, former President of the American Coke & Gas Construction Co., has been elected to succeed him.

Mr. Dorsey Ash, Assoc. M. Am. Soc. C. E., has accepted the presidency of the Pacific Clay Works, of Oakland, Cal., a corporation formed for the manufacture of high class building brick and other clay products. The works are located at Vallejo, Cal.

Mr. E. J. Bechtel, M. Am. Inst. E. E., Superintendent of the lighting department of the Toledo Railways & Lighting Co., has resigned to become Consulting Engineer for Hodenpyl, Walbridge & Co., of New York City—a firm dealing in electrical securities.

Mr. Geo. T. Smith was, on May 31, elected Vice-President of the Joseph Dixon Crucible Co., to fill the vacancy made by the death of Mr. John A. Walker. Mr. Geo. E. Long was elected Treasurer—an office also held by Mr. Walker, and Mr. Harry Dailey was elected Director and Secretary.

Mr. D. E. Curran, Vice-President and General Manager of the Alabama & Vicksburg Ry., the New Orleans & Northeastern R. R., and the Vicksburg, Shreveport & Pacific Ry., has been elected President to succeed Mr. C. C. Harvey, who resigned to become President of the New Orleans Terminal Co.

In this column last week we reported the appointment by Mayor Reyburn, of Philadelphia, of Professors Marburg and Spangler and Mr. McBride as a committee to investigate the Philadelphia filtration plants. Later information from Philadelphia stated that the three gentlemen mentioned declined to serve.

Messrs. Geo. C. Whipple, Assoc. M. Am. Soc. C. E., and Jas. H. Fuertes, M. Am. Soc. C. E., of New York, and R. S. Lea and J. E. Schwitzer, of Montreal and Winnipeg, respectively, have been appointed as a board of consulting engineers to investigate and report upon a new water supply for the city of Winnipeg.

Mr. Robert Mather was elected President of the Burlington, Cedar Rapids & Northern Ry., at the recent organization meeting of directors. C. L. Winchell was elected Vice-President, and Geo. H. Crosby, Secretary and Treasurer. The same men were elected to the corresponding offices of the Cedar Rapids, Iowa Falls & Northwestern Ry.

Midshipman Norman M. Smith and Ensign Robert S. Furber have been appointed to vacancies in the Corps of Civil Engineers, U. S. N., thereby reducing the number of vacancies in the grade of Assistant Civil Engineer to six. Ensign Furber has been attached to the U. S. S. "Indiana"; Midshipman Smith has been sent to the Rensselaer Polytechnic Institute at Troy for the usual course of preparation. It is not expected that there will be any more appointments to the Corps of Civil Engineers this year from the line, although enough applications have been received from senior midshipmen and junior offices to fill the vacancies.

The following changes have taken place in the personnel of the Reclamation Service, Washington, D. C.: Mr. Geo. R. Guernsey, junior engineer, has been assigned to the Lower Yellowstone Project; Mr. H. J. Kesner, junior engineer, to the Uncompahgre Project; and Mr. W. H. Heileman has been transferred from Berkeley, Cal., to Klamath Falls, Ore., to act as Superintendent of Irrigation on the Klamath Project.

Mr. George B. Foster, who was formerly in charge of the Wagner-Bullock Sales Agency in Chicago, and recently Assistant Sales Manager of the Allis-Chalmers Co., is now connected with the Power Improvement Co., of Milwaukee, at their Chicago Office, Fisher Building. The Power Improvement Co., Industrial and Commercial Engineers, make a specialty of industrial and water-works installations, as well as power plant design.

Mr. C. E. Grunsky, M. Am. Soc. C. E., Consulting Engineer of the Reclamation Service for California, Arizona, and adjacent territory, has tendered his resignation—to take effect as soon as the work which he now has in hand is completed; that work consists of an exhaustive report to Secretary Garfield upon the Arizona and California irrigation projects and proposed contracts. It is stated that he will practice as a consulting engineer, with offices in San Francisco and New York.

It was reported, and mentioned in this column on May 9, that Mr. Edgar Van Etten would resign the vice-presidency of the New York Central & Hudson River R. R.—in charge of the Boston & Albany division—to accept the presidency of the Longacre Electric Lighting & Power Co., of New York City. Mr. Van Etten, according to press reports of June 5, denies this. The reported choice of D. C. Moon, of Cleveland, Assistant General Manager of the Lake Shore & Michigan Southern Ry., as Mr. Van Etten's successor, is also included in the denial.

Obituary.

W. D. Hotchkiss, Assistant Engineer of the Board of Local Improvements of Chicago, died on June 3.

Robert Horner, Vice-President and General Manager of the Kosmos Portland Cement Co. of Louisville, Ky., died there on June 9.

A. J. F. Loretz, a consulting and constructing engineer of Brooklyn, died on May 27 at Los Angeles, Cal. He was an inventor, and his business for years has been largely in the direction of steam pump manufacture and practice.

Geo. L. Moats, Manager of the Four Metals Mining Co., Utah, met death by falling down a shaft on the company's property at Dugway, Toole County, on May 29. He was on a ladder, which broke under his weight. He came to Utah from Harrisville, W. Va.

John A. Grant, a constructing engineer of [illegible]ta, Ga., died at his home there on June 7 at the ag[illegible] 70. He built the Mississippi Valley R. R., now a [illegible] of the Illinois Central system, and also the Texas & [illegible]ic Ry., of which he was for a time Vice-President [illegible] General Manager.

Benjamin Franklin Hancox, one of the ol[illegible] railroad civil engineers in the country, died on Ju[illegible] at his home in Cliftondale, Mass., at the age of 82. [illegible]e began his railroad experience in 1847 with the P[illegible]dence & Stonington R. R., and for nearly 50 years [illegible] engaged in railroad construction in New England and [illegible] Middle States. In 1851 he was Resident Engineer [illegible]he work of the location and construction of the Nia[illegible] branch of the New York Central & Hudson River R[illegible] and in 1855 was associated with the Wabash R. R. [illegible]bout 12 years ago he retired from active practice. [illegible]wife and two sons—both of whom followed his profess[illegible]—survive him.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual meeting at Atlantic [illegible], N. J. Secy., J. W. Taylor, 390 Old Colony Bld[illegible], Chicago, Ill.

AMERICAN WATER-WORKS ASSOCIATION.
June 17-22. Annual convention at Toronto, [illegible]. Secy., J. M. Diven, 14 George St., Charleston, S. C.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19, 20. Annual meeting at Atlantic City, N. J. Secy., P. W. Drew, Wisconsin Central Ry., Milwaukee, Wis.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 20-22. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
June 25, 26. Annual meeting at St. Paul, Minn. Secy., G. P. Conard, 24 Park Place, New York, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Niagara Falls, N. Y. Secy., Ralph W. Pope, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
July 1-3. Annual meeting at Cleveland, O. Secy., W. T. Magruder, Ohio State University, Columbus, O.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Annual convention at the City of Mexico, Mexico, beginning July 8. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
July 30-31. First annual meeting at Boston. Secy., Dr. A. H. Elliott, 4 Irving Place, New York.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 7-9. Annual meeting at Norfolk, Va. Secy., Frank P. Foster, Corning, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting on June 5 a paper was presented by Mr. Arthur L. Adams, on "A Solution of the Problem of Determining the Economic Size of Pipe for High-Pressure Water Power Installations."

The problem to be solved was an economic determination of the proper size of pipe between that one of infinite diameter necessary to utilize the entire static pressure and one of such a small diameter that the entire head would be consumed in initial velocity at entrance and in overcoming resistances.

The solution, offered by the author of the paper, is based on the following proposition. The relation between the investment in any pipe-line, and the value of the energy lost in frictional resistance to the flow, is most economical wherein the annual cost of the pipe-line plus the annual value of the energy loss is a minimum. One table of data was computed, on pipe diameters, friction losses and value of friction losses, thickness, weight and cost of pipe, dynamic pressure and stress in pipe shell. Plotted curves were exhibited for various values of HP. loss, and cost of pipe for different sizes. The points of these curves which satisfied the requirements of $X + Y =$ a minimum were found graphically to be the points of tangency with right lines drawn at 45° angle to both coordinates. It was not attempted to prove this mathematically. It was shown that these points of tangency lie on a straight line between the origin, from which it follows that the tangent of the angle beween that line and the X axis expresses the economic ratio between the energy loss and cost of pipe-line. This ratio is constant whatever may be the unit values of such functions, and is about 0.40 to 0.42.

From these considerations the following rule was submitted: "THAT PIPE FULFILLS THE REQUIREMENTS OF GREATEST ECONOMY WHEREIN THE VALUE OF THE ENERGY ANNUALLY LOST IN FRICTIONAL RESISTANCE EQUALS 0.4 THE ANNUAL COST OF THE PIPE LINE."

The paper was briefly discussed by Mr. Emil Kuichling, who stated that such data would be more useful if computed on a basis of discharge rather than resistance. Two mathematical discussions were reported for printing in the proceedings.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, June 13, 1907.

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REVIEWS.

Water Bacteriology—Infective Bacteria of the Digestive Tract.

Reviewed by GEORGE C. WHIPPLE,* Assoc. M. Am. Soc. C. E.

THE BACTERIOLOGICAL EXAMINATION OF WATER-SUPPLIES.—By William G. Savage, B.Sc., M.D. (Lond.), D.P.H., Medical Officer of Health and Public Analyst, Colchester (England). Philadelphia, Pa.: P. Blakiston's Son & Co. Cloth; 5 × 8¼ ins.; pp. 297; 1 folding plate and 13 text illustrations. $2.50, net.

THE COMMON BACTERIAL INFECTIONS OF THE DIGESTIVE TRACT.—And the Intoxications Arising from Them. By C. A. Herter, M.D., Professor of Pharmacology and Therapeutics in Columbia University, Consulting Physician to the City Hospital, New York. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5 × 8 ins.; pp. 360. $1.50, net.

Among the many books which have been recently written on the bacteriology of water, this latest one, by Dr. Savage of University College, London, is by all odds the best. Although it is a comparatively small book, it covers the ground more thoroughly than any other, and the author has been able to do this only by elimination of matter elementary in character, and by the omission of a large part of the data early collected.

The first impression that one is likely to get from reading the book is that the bacteriological examination of water is no longer the simple thing that it formerly was. The mere determination of the number of bacteria in water is considered by the author as of little use, and he has therefore devoted but little space to it. On the other hand he has given a large proportion of the book to the significance of certain species such as B. coli, B. enteritidis sporogenes and the various streptococci.

In discussing the bacteria found in water he divides them into three classes, first, those which are natural to water and which are more or less widely distributed, which he terms normal inhabitants; second, those added to water from unpolluted sources, which he calls unobjectionable aliens, and third, those gaining access to water from polluted sources, which he calls objectionable aliens. Starting with this classification, he describes briefly, in fact rather too briefly, the ordinary bacterial flora of unpolluted waters. Then follow chapters on the bacteriology of excreta and sewage, and the bacteriology of the soil. The three principal groups of intestinal bacteria are described in detail—the typhoid group, the hog cholera group and the B. coli group, as well as such other intestinal bacteria as streptococci, and the cholera spirillum.

*Of Hazen & Whipple, Consulting Engineers, 220 Broadway, New York City.

Perhaps the most striking feature of the book is the discussion of the use of tests for B. coli and allied organisms as indicators of pollution. This subject is now in a somewhat chaotic condition, due partly to the fact that the term "colon bacillus" stands not only for a well defined species, but for a group of organisms; partly to the fact that methods for determining the presence of the typical organism and its allies are not uniform in character; and partly to the further fact that organisms similar to B. coli have been found from sources naturally unpolluted. Dr. Savage starts with the assumptions that "a perfect bacterial indicator of pollution must conform to the following conditions: (1) It should be abundant in the substance for which its presence serves as an indicator. (2) It should be absent, or at least relatively absent, from all other sources. (3) It should be easily isolated and numerically estimated. (4) Its character should be definite and not liable to variation whereby its distinctive characters might be impaired." After discussing the colon bacillus in extenso from these four points of view, the author concludes that B. coli is a reliable indicator of excretal contamination, but not necessarily human excreta; and that its value as an indicator of harmful pollution depends partly upon its numerical presence and partly upon the completeness with which the various attributes conform to those of the typical form. He emphasizes the fact that while it indicates excretal contamination, it does not indicate the source of such contamination, nor whether the contamination has been recent. He believes that it is even more important for a bacterioligist to know something about the source from which the sample is collected than it is for a chemist making an interpretation of a chemical analysis.

The chapter on the typhoid fever bacillus contains little that is new, but it presents the subject from the modern point of view. It is acknowledged that water is an unfavorable environment for this bacillus, and that under ordinary conditions the number of typhoid germs in water will gradually diminish from the time of its infection. Viability varies greatly with the character of the water, the germs living longer in relatively pure water than in sewage or in water from polluted sources. In discussing this subject, frequent reference is made to American studies, and in general the author's review of American literature is more complete than is found in most English books.

The discussion of the colon bacillus and the other indicators of pollution is based very largely upon the work done in England by Houston, Klein, Horrocks, MacConkey and others, so that to a considerable extent the book is written from the English point of view. Somewhat greater emphasis is placed upon the value of determinations of streptococci and B. enteritidis sporogenes than in America.

Another feature of the book illustrates the trend of modern bacteriology, namely, the emphasis placed on the various bacteria which cause dysentery and other diarrheal diseases. It has gradually become recognized that while typhoid fever is perhaps the most clearly defined water-borne disease, it is perhaps not the most important one, and the possibility that these diarrheal diseases may be derived from animal excreta as well as from human excreta is likely to lead to the establishments of stricter standards of purity for water supplies which are used without filtration.

The work closes with an appendix which contains a compact summary of procedures for the bacteriological examination of water and a bibliography which contains references to most of the important papers on the subject which have appeared during the last five or six years.

Any one who is interested in the study of typhoid fever and other water-borne diarrheal diseases will enjoy reading Dr. Herter's book, his latest work on the bacteriology of the digestive tract. It is written essentially for physicians, as evidenced by its medical bias, but it contains much to interest the sanitarian.

Dr. Herter first gives a general picture of the normal bacterial contents of the intestines and the normal changes which take place in the bacterial flora from infancy to old age. Of the 126 billion bacteria comprised in the average daily excreta of a human being, not all are B. coli, but other bacteria, such as B. bifidus, B. lactis aerogenes figure very largely and perform useful functions. The principal useful function is not so much one of aid to digestion as it is one of protection against the invasion of other organisms capable of doing injury. Organisms of the B. coli group, for instance, exert marked inhibiting powers against the typhoid bacillus and the paratyphoid bacillus.

The natural defenses of the digestive tract against organisms likely to do harm are well described. First there is the defensive action of the gastric secretion in the stomach, which, with its hydrochloric acidity effectually checks the growth of most non-sporulating bacteria. Then there is "the effect of the peptic ferment and the tryptic enzyme which leads to a quick destruction of bacteria whose vitality has been lowered by contact with the acid of the gastric juice." In the upper part of the small intestines B. lactis aerogenes is abundant; lower down representatives of the B. coli group increase in numbers and in the large intestine they predominate. Towards the lower end of the bowels the B. coli tend to die out, presumably from the effects of their own excretions or from the lack of water. The excreta of persons troubled with constipation contain relatively few B. coli.

In the stomach and the upper parts of the intestines the conditions are more or less aerobic; in the colon anerobic conditions prevail. "The ileum is the debatable land of the digestive territory." "It is there that in pathological processes a bacterial flora is established capable of producing substances that may damage the organism."

In disease the normal bacterial conditions of the intestines are disturbed. B. coli may practically disappear from the stools in certain types of dysentery. Errors in diet may favor the multiplication and penetration of pathogenic bacteria that have been present in a slumbering state.

The typhoid fever bacillus is classed as a hemiparasite, that is, a micro-organism which is invasive only when inoculated in considerable numbers. This organism, as well as the cholera germ and others, produces a substance termed an "agressin," which is thought to have the power of weakening the defensive powers of the host. While accepting the ordinary view that the portal of infection is the mouth, the author states that "there is some evidence to support the idea that at times the bacilli enter by way of the throat."

The author takes up infections with the paratyphoid bacillus, an organism quite commonly distributed, and the various kinds of dysentry bacilli and describes the bacterial conditions of the intestines when these are present. He has a good deal to say, also, regarding the secondary effects of the common intestinal bacteria when pathogenic forms are present.

The latter part of his book is devoted to a phase of the subject which is seldom considered, namely, the chronic intestinal derangements of bacterial origin. He shows that these are equally important, if not more important than the more acute attacks. This is extremely interesting in view of what the vital statistics have shown when the water supply of a city is improved by filtration, namely, that the general death-rate is decreased by an amount greater than that of typhoid fever. Apparently water-borne diseases represented by intestinal dis-

orders of a low order are even more important than typhoid fever and cholera—which are par excellence the water-borne diseases.

Dr. Herter's book is bound to have the effect of broadening our conception of the subject of infectious diseases of the digestive tract, and deserves a wide reading.

A Valuable Book on Copper Smelting—A Welcome New Edition of Howe's Steel.

Reviewed by BRADLEY STOUGHTON.*

THE PRINCIPLES OF COPPER SMELTING.—By Edward Dyer Peters, Professor of Metallurgy, Harvard University. New York and London: Hill Publishing Co. Cloth; 6 × 9¼ ins.; pp. 612; folding and other plates and text figures. $5.

THE MANUFACTURE AND PROPERTIES OF IRON AND STEEL.—By Harry Huse Campbell, Metallurgical Engineer for The Pennsylvania Steel Co., Maryland Steel Co. and The Spanish-American Iron Co. Fourth Edition. New York and London: Hill Publishing Co. Cloth; 6 × 9¼ ins.; pp. xxvi. + 639; numerous text illustrations and tables. $5.

As is told by the preface, this book was written partly for students, partly for those interested in the smelting of copper who have not had the necessary training to quite understand ordinary metallurgical books—the general reader.

Professor Peters set out to write a book upon the *reasons why* instead of upon the *means how*, and he has admirably succeeded. To the student the book yields a knowledge of the principles of copper smelting and for information on the subject of general manipulation and the application of these principles, he is referred to the standard works on the metallurgy of copper.

The work is divided into fifteen chapters, which deal with Methods and Collectors, First Principles of Smelting, the Principles of Roasting, the Chemistry of Smelting, the Practice of Roasting, Blast Furnace Smelting, Reverberatory Smelting, Pyritic Smelting, a Practical Study of Slags, Matte, the Production of Metallic Copper from Matte, the Refining of Copper, the Principles of Furnace Building, Applications of Thermochemistry, Miscellaneous and Commercial.

Chapter I. is an introduction of four pages in which wet versus dry methods are mentioned, and carriers or collectors of the precious metals defined. Of the three, metallic lead, metallic copper and matte, the latter is the great and almost universal collector of precious metals in copper smelting. The second chapter gives the object of smelting, the separation of the earthy and metallic portions of an ore, a concentration process. The fundamental ideas are most clearly laid down by considering the behavior of various ores in the blast furnace, taking four illustrations. The getting down to bed rock before laying the foundations and erecting a structure is well illustrated in this chapter (and through the whole book), and this is done in Dr. Peters' simple and delightful style which makes the subject specially easy in the reading. In these four cases the copper is assumed to be first in the metallic state, next as oxide, next as carbonate, last as chalcopyrite. The fact that it is the slag and not the metal which is always the smelter's first consideration is driven home. The constituents of the ores are followed in each of the four cases and the end products logically determined. The next chapter deals with the object, essential conditions and fundamental reactions of roasting. Here again we have brought before us a clearness and simplicity which clears away most of the imaginary difficulties due to the complexity of the subject as usually treated. The different conditions, etc., are brought forward each under a separate heading. In fact, Dr. Peters sometimes errs on the side of being too clear. For instance, in finding the weight of a metallic sulphide originally containing 30% sulphur, after roasting, he first finds the amount of oxygen the metal will take up and adds it to the weight of the metal. Then he gives the same calculation simplified by employing tons instead of pounds as units. Then a third method is given to arrive at the same result. A fourth and yet a fifth method are set forth to show that metallurgical calculations require mainly common sense and the simplest rules of arithmetic. These seem to be methods of arithmetic and unnecessary.

The fourth chapter describes the interior phenomena of the blast furnace and the formation of slag and matte. After this follows calculations on an illustrative smelting mixture and the determination of permanent factors to simplify the calculations, all of which is excellently given. The setting forth of the three laws of matte formation in blast furnace smelting of roasted sulphide ores, and then their consequences again show Dr. Peters' logical sequence of thought. This section, and that on calculation of the charge, in many books are worse than useless; they are a nuisance, for they so upset the student's mind that he once and for all determines that such metallurgical calculations are mere mental gymnastics.

Chapter V. takes up the practice of roasting, heap and stall roasting, treatment of raw sulphide fines and in a very readable way traces the evolution and development of the mechanical roaster with the O'Harra, Brown, McDougall and Pearce Turret furnaces as types. The next chapter on blast furnace smelting is exceptionally good and the calculation of the blast furnace charge clear, while the development of the blast furnace is given in the same lucid way that is characteristic of the whole book.

One of the best sections of the book is the chapter on reverberatory smelting which points out in an impressive way the reason why the old method was not always a success and why modern American methods have done so well. Other books have said the same thing, of course, but not exactly in this way, for after all a book's special value to a layman or student lies in what one absorbs and not what one has to dig out.

The eighth chapter, on pyritic smelting, is the longest in the book—about 125 pages. In it are given in detail the experiences and practice of Robert Sticht, General Manager of the Mount Lyell Mining and Railway Co., Ltd., many of which appeared in his paper "Ueber das Wesen des Pyrit-Schmelzverfahrens" Metallurgie III. It contains the gist of pyritic smelting and this, if no other, will make the book an acquisition to the practical man's library.

The chapter on slags contains several good tables, but like all chapters on slags gives one the erroneous idea of definite silicates, $xRO.ySiO_2$, being formed. That slags are not simple, but are composed of solid solutions, compounds and eutectics, just like metallic alloys, the work of the Geophysical Laboratory at Washington is now proving. Under the heading of Matte, the substance of two papers on their constitution are given. The first, that of Gibb and Philp (not Philip as in text), states that cuprous and ferrous sulphides combine to form a chemical compound corresponding to $5Cu_2S.FeS$. which enters into the composition of all mattes. The second paper by Röntgen indicates the presence of at least three chemical compounds of Cu_2S and FeS. To these might be added a third by Hofman, who finds no compounds at all. The section contains some very interesting data on the subject of mattes, together with a table of analyses of copper mattes from some of the chief copper districts of North America.

Chapter XI. deals with the production of Metallic Copper from matte, describing the Welsh Blister process the various processes for the separation of the precious metals, the Bessemer process and the Baggaley process which aims to produce a low grade matte by smelting only and enrich it in a basic converter, adding silicious ore to flux the iron.

The next chapter, on the refining of copper, is rather short—25 pages only—but its brevity is made up for by its quality. We are given the essence of the investigations of Kiiler, Gibb, Van Liew and others.

The thirteenth chapter, on the principles of furnace building, is properly kept in a section by itself instead of, as is usual, being wedged in amongst the theory of smelting at the beginning of the book. The section on the applications of thermochemistry was written by Prof. J. W. Richards, of Lehigh University, and consits of 25 pages of methods and calculations from which we learn where the heat comes from and goes to in copper smelting, its amount and the like; a very excellent little chapter indeed. The last chapter deals with smelter tariffs and penalties and kindred matters.

The index is good, with plenty of cross references, making it an easy matter to look up any section or subject.

This book is a pioneer along the text-book line. The teaching of the principles, after all, is the most important, and Dr. Peters deserves hearty congratulations and thanks for producing such a clear, concise and readable book. It is to be hoped that the example may be followed by others and that we may have similar books on lead, gold, silver, etc., and that our teaching may begin with the principles, or reasons why, and end with the applications, or means how.

Had Dr. Peters added a bibliography at the end of each chapter the book would be even more valuable.

The first, second and third editions of Mr. Howe's book are too well known and their great value too well appreciated to require any eulogy here, so this notice will be confined to a discussion of the changes and additions between the last edition (1904) and this one. The changes are mainly in the form in which the information is presented and in this respect very great improvement and condensation has been made where it seemed already as if there were little opportunity. The condensations are especially commendable because they have reduced the book by over 200 pages and, at the same time, actually increased the information contained. In the substance of the book there has been comparatively little change: the statistical data are nearly three years behind the times and the same is true to a certain extent of the data on processes. For example, the use of dried air in blast furnaces, recent improvements in the Bessemer and open hearth process, especially the Duplex process, special open hearth processes and small converters, the more recent work on segregation, heat treatment and alloy steels are but cursorily treated. Nevertheless the improvements in this edition are great enough to cause it to be a valuable addition to a library which already contains all the previous editions.

BULLETIN OF THE IMPERIAL EARTHQUAKE INVESTIGATION COMMITTEE.—Vol. I., No. 2, March, 1907. Tokyo, Japan: Address the Committee. Paper; 7½ × 10 ins.; pp. 70. With several plates and numerous illustrations in the text.

This pamphlet is of more general interest than other bulletins of the series, chiefly because of the first of the five papers which it contains. "Preliminary Note on the Formosa Earthquake of March 17, 1906." The phenomenon described there was the second one of a series of three correlated seismic shocks in the same district of Formosa, connected with the formation of a long fault extending transverse to the island. The author, Prof. F. Omori, ascribes all three shocks to the formation of an underground cavity, which grew in three

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separate stages. He also indicates the existence of periodicity in the aftershocks of the earthquake, periods of 4½, 9, 12 and 33 days being observed. He found the same periodicity to exist in the atmospheric pressure in Japan, and concludes that a connection is probable between the cause of tectonic earthquakes of the Formosan type and atmospheric pressure. Another interesting article in the pamphlet gives seismographic records from several stations of the Valparaiso earthquake and the Aleutian earthquake (half an hour earlier), and states their principal characteristics.

Three Good Electric Railway Books.

Reviewed by HENRY H. NORRIS.*

AMERICAN ELECTRIC RAILWAY PRACTICE.—By Albert B. Herrick, Consulting Engineer, and Edward C. Boynton, General Manager of the Orange County Traction Co. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 403; 223 illustrations, mostly in the text. $3, net.

ELECTRIC RAILWAY ENGINEERING.—By H. F. Parshall, M. Inst. C. E., Consulting Engineer, and H. M. Hobart, M. Inst. E. E., Consulting Engineer. New York: D. Van Nostrand Co. Cloth; 7¼ × 11 ins.; pp. 475; 437 illustrations, partly in the text. $10, net.

ELECTRIC RAILWAYS.—A Series of Papers and Discussions Presented at the International Electrical Congress in St. Louis, 1904. Republished by the McGraw Publishing Co., New York, by Special Arrangement with the International Electrical Congress. Cloth; 6 × 9½ ins.; pp. 447; illustrated. $3, net.

The number of books dealing with electric railway practice has been small, but now appears to be increasing rapidly. Just twenty years have elapsed since Mr. F. J. Sprague and his associates made a commercial success of the now historic electric street railway in Richmond, Va. During eight years immediately preceding 1887 numerous experimental cars were constructed by Sprague, Edison, Daft, Bentley, Knight and others in this country. As early as 1879 Seimens operated a small electric locomotive hauling passenger trailers on the grounds of the Berlin Exposition, and during the same year his company placed in regular commercial service a short line at Lichterfeld near Berlin. The latter was probably the first commercial electric road in the world, while the Richmond road was the pioneer in this country. Until 1890 the railway motor was in its experimental stage, but its development was stimulated by a demand for which manufacturers of electrical machinery were poorly prepared. Between 1890 and 1900 practically every horse and cable car in this country was displaced, while at the same time the electric roads were creating new business for themselves by suburban and interurban extensions. At the present time the electrification of steam railroads has begun, and it is difficult to predict the outcome.

The changes in equipment and in conditions of operation have been so rapid that electric railway engineers have not been able to produce satisfactory books, but practice is now being standardized and some excellent works have recently appeared. Electric Railways by Ashe and Kelly was one of the first in this country, and Electric Railways and Tramways, by Philip Dawson, of England, was still earlier. Hand-books by Dawson and by A. B. Herrick have been in use for some years. The present work by Messrs. Herrick and Boynton contains an excellent summary of up-to-date practice in this country. As the scope of the work is large and the compass small, it is necessarily condensed, and only a general treatment of each topic is possible. The whole subject is treated, from the preliminary engineering estimates of the possible earning capacity of a proposed road to the latest forms of transfer tickets and of fare-collecting devices. The material is entirely descriptive and non-mathematical, not a formula appearing from cover to cover. Instead, there is a wealth of general practical information arranged in readable fashion and well illustrated from photographs and drawings. The original contributions consist largely of comments upon current practice based upon the wide experience of the authors. The remainder of the text is made up from articles recently published in the Street Railway Journal and from contractors' specifications.

The first two chapters cover the general engineering preliminaries such as estimates and field engineering. Location and construction of track, power stations and overhead circuits are next described and illustrated from the best current practice. The remainder of the volume deals with the many details of operation beginning with the essential features of time-tables, schedules, dispatching and signals. A long chapter on rolling stock and its equipment includes descriptions of car bodies with specifications, car wiring with insurance rules, motors and controllers. The construction of a modern repair shop, with accessories, is described in detail and many practical operating hints are given. As a whole, the book is well printed, bound and indexed. It contains many of the same illustrations as Gotschall's Electric Railway Economies, which occupies to some extent the same field. It will be convenient for reference, especially to those engineers who are not regular readers of the electric railway periodicals and to those who do not have access to bound volumes of the Street Railway Journal.

The most comprehensive book on electric railway practice which has yet appeared is that just issued under the authorship of the well-known electrical engineers, Messrs. H. F. Parshall and H. M. Hobart, of London, England. The experience gained by the authors in the preparation of numerous other works on the design and operation of electrical machinery has been utilized in producing a model of mechanical and literary excellence. No reasonable expense has been spared in illustrating, printing and binding, and while the price is large it is not disproportionate to the expense of production. A general idea of the wealth of material may be gained from the statement that there are 437 illustrations, including numerous folding plates, and many of the illustrations contain a large number of separate diagrams. There are also 123 tables of data covering the entire field of electric railway practice. The material has been gathered from all available sources of information of various degrees of accessibility, and it is systematically arranged for general reading or for reference. The authors have combined with the data the results of their own experience and have produced as logical and connected a discussion as is possible with such a wide range of topics.

In general the plan includes three main natural divisions of the subject—the mechanics of electric traction, the generation and transmission of the electrical energy and the rolling stock. Under the head of mechanics are included all those items which affect the time-velocity characteristics of cars and trains. These are constant speed and acceleration resistances, railway motor characteristics, coasting and braking. From these quantities the loads upon the power and sub-stations may be determined, and methods of predicting these loads are given. In Part II. the power station, the high tension transmission system, the sub-station and the low tension distribution system are taken up in the order mentioned. The electrical power is thus followed in its path from prime mover to car. The rolling stock described consists of all types and varieties of electric locomotives and other motor cars, with all necessary accessories.

In the first chapter the authors show that train resistance is a more definite matter than is usually supposed. They compare the results of numerous experiments and deduce useful curves and tables to aid in predetermining the velocity-time diagrams, to which they apply the name "Section characteristics." To illustrate the application of the data a variety of practical examples are worked out and the results are reproduced graphically. An ingenious and unique method is employed for exhibiting the results of the calculations. Many of the diagrams are arranged in tables in vertical and horizontal columns, by following either of which the results of varying one factor of the problem may be readily determined by inspection. For example, Fig. 19 shows the variation in the speed-time and distance-time diagrams for several rates of acceleration, for several schedule speeds and for a particular distance covered. For each rate of ac-

*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

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celeration and each schedule speed a complete pair of diagrams is given. Figs. 20, 21, 22 and 23 contain the same information for other distances, the entire series ranging from 0 to 3.2 miles per hour per second acceleration, 10 to 80 miles per hour average speed and 0.5 to 8.0 miles covered per run. This is a sample of the complete manner in which the problems are solved. The effect of the schedule speed upon the motor characteristics is duly considered, especially with reference to the rise of temperature in the motors. Finally the data are reduced to the form of electrical energy input per ton-mile under all possible combinations of operating econditions.

Part II. begins with a synopsis of English practice in power plant construction and operation. The discussion is from the "economic balance" standpoint, that is, each element of operation and each device is examined to ascertain whether or not it gives the best financial return for the investment. The chapter on high tension transmission is almost entirely devoted to underground cables and their installation. In England high tension circuits are usually placed underground, especially in densely populated sections, hence the authors have treated cable work very fully. A few pages are given to overhead transmission, but no details of practical construction are included. Seventy-two pages are allotted to the sub-station, which is consequently described elaborately. Each element is taken in turn and its performance analyzed. These elements are: The synchronous motor, the rotary converter, the accumulator, the transformer and the auxiliaries. The general principles of sub-station location, design, construction and operation are fully illustrated. The rotary converter section is so full as to comprise a very complete treatise on that subject. In the pages devoted to the distributing system many details of current practice in overhead and third-rail construction are given with special reference to the latter.

The last part of the book consists largely of detailed descriptions and drawings of recent direct and alternating current locomotives and motor cars. Every important advance is touched upon and the salient features of each type of car are brought out. Among the locomotives given prominence are the New York Central No. 6,000, the Baltimore & Ohio gearless types of 1896 and 1903, the Paris and Orleans, the Valtellina three-phase and several others. The subject of trucks occupies a separate chapter. The practice of a number of leading railway companies is described and the important principles underlying the design of successful trucks are deduced.

One of the most momentous developments in the railroad and electrical fields is the electrification of steam roads. To those interested in the changes now under way or contemplated, a book like that under consideration will prove enlightening and stimulating. A quotation from the preface will show the attitude of the authors toward this matter:

> With the gradual extension of the application of electricity for all purposes along the different railway systems, the distances to which electrical working becomes profitable will be extended, and with the installation of such power systems as are now becoming common in Great Britain, it would appear that the distance may be indefinitely extended.
>
> The advantages of electric traction, like those of the central power installation, increase with the magnitude. The diversity and load factors increase therewith, as also the various economies incidental to an improved load factor. As an ultimate result, freight haulage may be anticipated. The electrical output per mile of track must be considerable to bring the cost of haulage per haulage per ton-mile by electricity to that now common by steam.

The McGraw Publishing Company some time ago republished the power transmission papers delivered before the International Electrical Congress in convenient form for reference, and they now reprint the electric railway section of the transactions. The management of the Congress was fortunate in securing papers from a number of prominent engineers and covering a large part of the field of electric railway work. Their aim was to record accurately and exhaustively the status of the art and to indicate the directions in which progress was to be expected. They succeeded admirably in their plans, as is evident from the fact that three years later the papers still have general interest and are extremely valuable. The transactions were published by advance subscription and they are now practically out of print. The papers, therefore, must be reprinted by private enterprise or they will be inaccessible except to the members of the Congress or to those in reach of large libraries.

Twenty papers were delivered before the railway section and of these nine or nearly one-half dealt with alternating current transmission and car equipment. This indicates how important the new development was considered, for at that date practically no alternating current car motors were in operation in this country. The remainder of the papers were divided between general and historical description and details of practice in electric current distribution. Mr. F. J. Sprague, the pioneer in street railway electrification, traced the historical development of electric railways from the beginning in 1834 to the era of steam road electrification, just beginning at the time of the Congress. Mr. B. J. Arnold, then President of the American Institute of Electrical Engineers and President of the Congress, added further historical notes on alternating current practice, dating back to 1896, when the rotary converter was beginning to be exploited. Mr. Arnold described an interesting electric-pneumatic car equipment in which the motors could be maintained at constant speed regardless of the speed of the car and in which braking and coasting energy could be stored in air cylinders. Mr. Philip Dawson, of London, presented some statistics of electric railway operation in England showing, among other conclusions, that the population of London was carried only one-half as often as that of New York.

In the paper on Alternating vs. Direct-Current Traction, by Dr. F. Niethammer, occupying, with discussion, 78 pages, a complete synopsis of the railway situation in Europe was given. The author discussed all varieties of motors and compared their performance from the engineering standpoint. The mathematical contributions of Dr. C. P. Steinmetz, Messrs. Max Deri, Friedrich Eichberg, O. S. Bragstad and Ernst Danielson presented the theory underlying the operation of alternating current motors and supplemented the practical discussions. A number of other papers treated details of construction and operation, the whole forming a fairly consistent collection of timely information. The present publishers have greatly increased the value of the original work by including a complete subject index which is lacking in the Transactions.

Dr. Louis Bell, in a short preface, admirably pictures the present electric railway situation. In commenting upon the apparent delay in the fulfilment of the prophecies made at the Congress he states, "Achievement follows foresight, and commercial adaptation trails in the rear, so that one need not wonder at the apparently gradual progress in the actual equipment of roads. Such has been the history of other improvements, of the application of alternating currents to lighting and of polyphase currents to the electrical transmission of power. This volume records the field notes of the advance guard."

THE PREVENTION OF ACCIDENTS.—By F. W. Johnson. New York: McGraw Publishing Co. Stiff paper; 5¾ × 8½ ins.; pp. 37. 25 cts., net.

To quote from the preface:

> The purpose of this pamphlet is to assist the management of street railway companies in the laying of a suitable foundation for the work of instructing and of educating their carmen concerning practical means of preventing the more common classes of accidents, and of the proper handling of these accidents.

THE TECHNICAL YEAR-BOOK, 1907.—Edited by Arthur C. Kelly, Assoc. M. Inst. C. E., and Charles Weekes. London, England: Percival Marshall & Co. Cloth; 4 × 6 ins.; pp. 399; illustrated. 5s., net; American price, $2, net.

The attempt of the editors of this handbook has been to select such portions of all engineering journals and reports as will show changes in and additions to general engineering knowledge and practice. All material shows its source, so that the more complete articles can be found. Naturally, the data on costs are give[n] British terms, and largely based on Engl[ish] practice. This makes the volume of less use [to] American than if it were arranged from th[e] American point of view. The portions on fuels, [steam] plant losses, steam turbines, gas engines, [centrifugal] pump tests, traction tests, losses [in] machine tools, alloys, electric fuses and illum[ination], lead easily to at least a superficial knowl[edge] of what has been accomplished during the [year]. The index seems complete. The volume w[ould] be useful as a supplement to standard handboo[ks] although for such use the pages of conver[sion] tables, properties of materials, hydraulic da[ta] and electrical resistances are unnecessary.

RAILWAY ORGANIZATION AND WORKIN[G].—A Series of Lectures Delivered before the Railway [Course] of the University of Chicago. Edited by E[rnest] Dewsnup. Chicago, Ill.: The Univer[sity] Press. Cloth; 5 × 8 ins.; pp. 498; three folding plates and two text illustrations, $2, net; $2.16, postpaid.

How is a railway run? There are treatises to be had nowadays on almost every branch of human activity; but if one desires to know how the most complex organization in our modern industrial life is conducted, where may he look to find the information? The book before us comes as near being a treatise on railway operation as anything now in print that we recall. As some of our readers may be aware, the University of Chicago two years ago established courses of study in railway transportation under the auspices of an advisory committee made up of a number of prominent officials of the railways centering at Chicago. Lectures have been delivered before the students in these courses by a number of railway officials, each describing the work of a particular railway department; and the book as a whole gives thus a pretty accurate picture of the activities and responsibilities of many of the departments of railway service.

We say many, for not all the departments are here represented. We find nothing, for example, on the duties of the Chief Engineer or the Superintendent of Bridges and Buildings, or the Superintendent of Motive Power. On the other hand it is true that the work of these departments is comparatively well known and well covered in existing literature, while the work of the Industrial Commissioner, the system of expediting fast freight shipments, and the task of car distribution are comparatively unknown.

We may note here that among the contributors to the book who are well known to engineers are Mr. L. C. Fritch, formerly Secretary of the Railway Engineering Association; Mr. A. S. Baldwin, Chief Engineer of the Illinois Central; Mr. J. H. Ames, Chief Engineer of the American Car & Foundry Co., and Mr. W. R. McKeen, Superintendent of Motive Power of the Union Pacific Ry.

The book should be placed in every reference library used by railway employees; and any young engineer in railway service will find it worth while to read the book, since it will aid him to gain a broader outlook upon the industry in which he is playing a part.

GRAPHITE.—A Study with Tests. By W. F. M. Goss, M. Am. Soc. M. E., Dean of Schools of Engineering, Purdue University, Lafayette, Ind. Jersey City, N. J.: Jos. Dixon Crucible Co. Paper; 6 × 9 ins.; pp. 43; 20 text illustrations, 3 curves and 3 tables. 25 cts.

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To quote from the preface:

The interest in graphite lubrication has grown to such an extent that the Dixon Company is frequently asked by superintendents of machinery, by students, and even by instructors in mechanical departments of colleges, for detailed information relative to the function of graphite as a lubricant. It is because of such inquiries and because of the belief that the experiments of Prof. Goss have a positive value to the mechanical world that the tests are now put into print.

Two Books on Steam Engineering.

Reviewed by STORM BULL.*

THE STEAM-ENGINE AND OTHER HEAT-MOTORS.—W. H. P. Creighton, U. S. N. (Retired), Professor of Mechanical Engineering, Tulane University of Louisiana. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 499; 198 illustrations in the text and one folding late, $5.

MODERN STEAM ENGINEERING.—In Theory and Practice. A New, Complete and Practical Work for Steam-Users, Electricians, Firemen and Engineers. By Gardner D. Hiscox, M. E., Author of "Gas, Gasoline and Oil Engines," etc. With Chapters on Electrical Engineering by Newton Harrison, E. E., Author of "Electric Wiring, Diagrams and Switchboards." New York: The Norman W. Henley Publishing Co. Cloth; 6 × 9½ ins.; pp. 487; numerous illustrations and tables. $3.

It is very evident both from the preface and from the contents of the first of these books that the author has intended to write a text-book for students and not a reference book for the practicing engineer. This has limited the scope of the book, and it would seem that the author has in general understood how to draw these limitations correctly. At least there is very little that does not belong in a text-book on the subject announced in the title. It is evident that the book is intended to serve as a text-book on the subjects of thermodynamics and of the steam engine, etc., but after a careful examination the reviewer is of the opinion that some of the subjects treated have received altogether too little attention. This is notably the case with thermodynamics, which takes up less than 75 pages of the book, in which space it certainly is impossible to give an adequate treatment of such an important subject. It is very possible that it would be found impracticable to treat adequately such a large number of subjects as are found in this book in the space of 500 pages—and the reviewer is of that opinion—but if anything was to be sacrificed it should not be such a fundamental subject as thermodynamics.

The scope of the book can best be seen from an enumeration of the titles of the 18 chapters into which the book has been divided: (1) Review of elementary principles and general view of steam engine plants; (2) Steam-engine indicator and its calibration; (3) Curves and the work of expansion; (4) Zenner and Bilgram valve-diagrams and design of plain slide valves; (5) Measuring the effects of heat; (6) Measuring the effects of heat on water and steam; (7) Measurement of heat losses; (8) Entropy; (9) Condensers and air pumps; (10) Small auxiliaries; (11) Multiple expansion engines; (12) Revolution control; (13) Speed variation control; (14) Steam engine tests; (15) Superheated steam and steam turbines; (16) Gas engines and gas producers; (17) Boiling in vacuum; (18) Refrigeration. In an appendix are found a number of useful tables. What at once struck the reviewer when looking through this list was the very peculiar sequence and arrangement of the subjects. What is the object, for instance, of treating in detail the indicator long before the student knows anything of the action of the steam in the cylinder? The same remark may be made about Chapter III., in which the curves of expansion are considered. Would it not be very much better if the subject of thermodynamics, as found in Chapters 5, 6, 7 and 8, had preceded 2 and 3? It is also quite peculiar that the subject of superheated steam is only taken up in connection with the steam turbines, leaving the impression that superheated steam is only used for steam turbines. Why boiling in vacuum should be accorded a separate chapter in a book of this kind is also somewhat of an enigma. It might also be criticised that the standard rules for conducting engine tests have been divided into a large number of parts and these parts inserted at places in the book where the author thought they belonged. It would seem that if he thought it best to incorporate these rules into his book he would have done better if he had kept them together as a whole.

After having indicated these points, in which the reviewer thinks the book ought to be criticised, it is with pleasure that he turns to the many points for which the author ought to be praised. First of all the book is clearly written and, as stated in the preface: "While an earnest effort has been made to make the work simple, no principles have been omitted that should be contained in a work intended for undergraduate students of college grade." It is also noticeable, as also pointed out in the preface, that the formulas for the general and more complex use have been developed first, from which then the simple cases may easily be derived. This principle is not always followed, but has, in the opinion of the reviewer, a very decided advantage over the opposite method of procedure. Another very good feature of the book is the large number of numerical examples worked out, as well as the series of problems which are to be worked out by the student. There is no question that a principle is never so well understood as after a number of problems based upon this principle have been solved.

Some of the chapters are especially good; as such ought to be mentioned those on Condensers and Air Pumps, Multiple Expansion Engines and Revolution and Speed Variation Control, which chapters are very satisfactory, both as to what they contain and as to the manner in which the matter is presented.

Among the illustrations there are rather too many picked up from the trade catalogues or from other books of similar nature. These do not always fit in well with the text. But otherwise, the book is excellent as to the dress given to it by the publishers; the reviewer predicts a large sale for the book, as it really fills a want—at least to quite an extent—which has been felt for some time.

The second book noted in the heading, "Modern Steam Engineering," by Mr. G. D. Hiscox, is of exactly the same kind as he has produced in his Gas Engines. A lot of useful information is contained in the volume, but this information is accompanied by so many inaccurate statements that the book becomes of doubtful value. According to the title one ought to expect to see the steam engine, etc., treated from both the theoretical and practical side. When, however, the reader discovers that not even the simplest formulas are deduced in the book, but that they are simply placed there on the authority of Mr. Hiscox, the reader soon begins to think that the theory of Steam Engineering is sadly neglected. In the preface it is stated that it has been written for the student and the engineer. The reviewer will state that it is his opinion that these words should be understood as meaning the young men who are studying to become stationary engineers. For such the book ought to be quite useful, although it is a pity that the author should not be able to convey whatever useful information he has to impart without making so many erroneous statements as he does. These can be found on almost every page of the book, so that the reviewer cannot but pity the stationary engineers who are to digest this agglomeration. It is only because of the difficulty of choice between all the errors contained in the book that the reviewer abstains from quoting any of them.

As in all of Mr. Hiscox's books there are many and well executed illustrations, which, as the publishers inform us, all have been especially made for the book. Altogether the book presents a very pleasing appearance.

*Professor of Steam Engineering, University of Wisconsin, Madison, Wis.

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Scientific Publications

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The Locomotive, Steam and Electric.

Reviewed by G. R. HENDERSON,* M. Am. Soc. M. E.

LOCOMOTIVES.—Simple, Compound and Electric. By H. C. Reagan, Locomotive Engineer. Fifth Edition, revised and enlarged. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¼ × 8¼ ins.; pp. 932; 494 illustrations, mostly in the text. $3.50.

The original preface to this work states that the author, who is a practical engineer, attempts to present a practical treatise on the locomotive engine, and tries to describe the manner in which the locomotive is handled in service, his object being to enable an engineer to perfect himself and obtain a thorough understanding of the locomotive and what should be done in case of accident. After the different chapters a series of questions and answers are arranged with the idea of having the book used by master mechanics or traveling engineers for the examination of candidates for promotion. These questions, however, are only appended to the first portion of the book, as the latter part has omitted this form of make-up.

The preface to the 5th edition states that the work has been revised in order to include the latest developments of steam and electric locomotives, and considering the rapid development of the latter the author thinks that engineers should be generally familiar with the principles underlying their construction and operation.

The arrangement of the book is rather peculiar: for instance, the subject of boilers is first treated by seven pages which describe only the Belpaire type of boiler and a few of the fittings, which are followed by five pages of questions; and then again beyond the middle of the book there are about twenty more pages describing different types of boilers. The same thing is true of the valve motion, to which there is allotted ten pages of description and nine pages of questions in the front of the book, and later on there are different types of valve gears described in connection with individual locomotives that are illustrated. It is probable that this peculiar arrangement was due to a desire to retain some of the original stereotype plates, otherwise we do not see how this matter could be so distributed through the book instead of being accumulated under the proper respective headings. Many of the illustrations are taken from trade catalogues or similar literature, and while the majority of them are very clear and good, yet there are some that are of very little value as illustrations.

Considering the great importance which the boiler of a locomotive bears to the whole machine, it is rather surprising to find only about twenty-five pages, altogether, of description allotted to this particular part of the machine. In speaking of the staybolts of the Belpaire boiler the author refers to them as radial stays, which is a term the reviewer has never before heard used as applied to a Belpaire boiler, as the stays are parallel and are certainly not radial. In connection with the front end no mention is made of the netting which is such an important thing in some sections of the country and at times gives so much trouble. The first portion on valve motion gives no reference to the piston valve, but later in the book there are about a dozen pages devoted to this subject, but from the wording of the descriptive matter it would seem that the Brooks Locomotive Works is practically the only concern that builds engines with piston valves, as the description is entitled, "Brooks single expansion locomotive using piston valves." The piston valve has become so common that it seems odd that no reference is made to other users outside of the Brooks Locomotive Works, for while this company did a great deal to develop the piston valve, yet it was not altogether the pioneer in that line of work.

There are a number of important items which are not mentioned, including the engine truck, engine tender, siphons and water valves for same. In describing the various details used in connection with steam locomotives even the well-known monitor injector is not referred to, nor is there any mention of the modern bulls-eye lubricator, nor of the tandem metallic packing which has been found so necessary for certain types of compound engines. It is hard to account for such omissions in view of the statement in the preface to the effect that it was the desire of the author to treat of the latest developments of the locomotive.

The chapter on locomotive frames illustrates a consolidation frame without a splice at the front end frame, and the text refers to this feature, whereas we all know it would be an impossibility to construct an engine and put it together with such a frame.

Again, on page 353, there is quite a description of the Philadelphia & Reading single driver locomotive, a machine which was taken out of commission perhaps ten or fifteen years ago and has never been duplicated in American practice. The subject of superheaters is perhaps one that is exciting most interest in locomotive construction at the present time, but only nine pages are given to this subject, important as it is. Oil burning locomotives are given about fifteen pages, but there are some very erroneous statements in connection with this portion; for instance, on page 550 the statement is made that "the absence of sulphur in the fuel makes its action on the boiler plate much less destructive than when using coal as fuel." In view of the fact that oil-burning fire-boxes only have about one-third the life ordinarily of coal-burning fire-boxes, we are very much surprised to see this statement. The theoretical heating power of fuel oil is also given as from 27,000 to 28,000 heat units, or an evaporation of 28 to 29 pounds of water from and at 212 degrees. This statement is 30% higher than any actual facts or other similar statements that we know of.

Most railroads experience a great difficulty in getting engineers to properly make out their work reports, and this is exemplified in the book by the following example: "Buddey sock lost off the Jumbo." This is interpreted later to mean that the cinder hopper cap was lost, but considering that a man will at times make such reports it seems as if more than one page should be devoted to the important business of explaining how to make such reports intelligible and reliable.

Compound locomotives are very liberally treated and particularly foreign types, upon which subject there are about 200 pages, these being mixed in with American designs. The review of these different types seems to be fairly complete, however, and some of the illustrations of the details are very clear and distinct.

It seems to the reviewer that the best part of the book is the 320 pages on electric locomotives, in the course of which the latest types of New York Central and New York, New Haven & Hartford are well set forth. The wiring diagrams in this portion are particularly creditable and present this subject to the practical engineer in as clear a way as could be expected. Some portions of the power house equipment, however, are very lightly touched: for instance, the subject of prime movers for generating alternating current is allotted three illustrations and one page of text. The book concludes with about a dozen pages on motor cars and similar equipment.

There is no doubt but what a great deal of information for the practical engineer can be obtained from this book, but it is a pity that the arrangement has not been more systematic and that so many prominent and important parts of the locomotive have been omitted from discussion. However, for those men for whom it is intended the book is well worth its price.

*Consulting Engineer, 20 West 34th St., New York City.

Reprints on Polyphase Machinery.

Reviewed by HENRY H. NORRIS.*

MODERN POLYPHASE MACHINERY.—By Andrew Stewart, Assoc. M. Inst. E. E., Author of "The Application of Electric Motors to Machine Driving," etc. London, England: S. Rentell & Co., Ltd. New York: D. Van Nostrand Co. Cloth; 4¾ × 7½ ins.; pp. 296; 181 illustrations in the text. 5s., net; American price, $2, net.

The author has revised and republished in book form a series of magazine articles. These were written as an introduction to the subject, and they are descriptive in character. The illustrations are from modern machines, but the execution is very crude, in fact, the book is distinctly cheap in appearance. The style is informal and readable and to those already somewhat familiar with the general appearance of electrical machinery it should prove interesting. It is non-mathematical and hence treats only of the practical features, design and operation.

There is no claim for nor evidence of originality in material or treatment, the usual range of topics being included. These are: The construction and operation of polyphase generators, including turbo-alternators, synchronous motors, rotary converters and induction motors. Some space is given to the testing of these machines.

The size of the volume is convenient as it can be carried in the pocket, although not a pocketbook in the ordinary sense.

*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

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Sewerage and Sewage Disposal in Eastern Countries.

Reviewed by GILBERT J. FOWLER.*

DRAINAGE PROBLEMS OF THE EAST.—By C. C. James, M. Inst. C. E. London and Bombay: The "Times of India" Office. Cloth; 10 × 7 ins.; pp. 378; 44 illustrations in the text and 77 plates in separate volume.

The work under review is the second and much altered and enlarged edition of Mr. James's "Oriental Drainage." Mr. James was for many years Chief Sanitary Engineer to the Bombay Municipality, during which time he also had occasion to advise other Eastern cities, and he has conducted, in addition, an important series of experiments on sewage purification. Recently he has been appointed Engineer in Chief to the Sewerage of Cairo. There is probably, therefore, no one better qualified to speak on the engineering aspect of the sewage question as it has to be dealt with in the East.

The book is in two volumes, the second volume consisting wholly of lithographic plates. The first volume contains two parts, the first dealing mainly with general principles and the second with their application to various important and typical towns. There are also three appendices devoted, respectively, to a reprint of Messrs. Travis and Ault's paper (Inst. C. E., 1906) on the Hydrolytic Tank, to various specifications and to a glossary of terms.

After a short introduction describing the special conditions of sewerage work in the East the first chapter deals with several systems of drainage, a good account being given of the Shone ejector system and of the Liernur vacuum system. Hydraulic and electrical pumping are also described, but the suitability of these for Eastern conditions is not so evident as that of the first-named systems.

In Chapter II. the various problems connected with the construction of sewers in the East are dealt with. A good account is given of sewer ventilation. Mr. James describes carburetted hydrogen (C_2H_4) as a product of the decomposition of vegetable matter; the reviewer has made many analyses of gas from sewage, including emanations from old and stagnant sewers, and has never found a trace of C_2H_4; if present, it must be certainly due to leakage of coal gas. This chapter might well have been followed by Chapter VII., on surface water and subsoil drainage, a problem which calls for special treatment owing to the uneven distribution of rainfall in India.

Chapter III., on public conveniences, embodies a good deal of the author's practical experience. In latrine design, especially, exact detail is of great importance, and many things have to be borne in mind which would not naturally occur to the European engineer. This chapter, therefore, is likely to be particularly useful. Chapter IV., on house connections, clearly brings out the many special difficulties encountered in an extremely important if minor branch of engineering.

Chapters V. and VI. contain a most interesting account of Mr. James's experiments at Matunga on different methods of sewage purification, especially in regard to the utilization of the gas from an aerobic decomposition, or "tank gas," as it is called. As the reviewer proposes to deal with these experiments in a special article, only one or two points need be referred to here. It is unfortunate that the figures for nitrates in the tables of analyses are not always given in the same terms, as comparisons are rendered difficult. Exception must be taken to the statement on page 152 that "the present state of our knowledge has now so far advanced as to leave little to be learned in the treatment of ordinary as opposed to trade sewage." It is true that by the system of "trial and error," so characteristic of English enterprise, a certain body of empirical knowledge has been built up, not without heavy expenditure; but sewage purification is still far from being an exact science, and a great deal of research remains to be done before a sewage works can be designed throughout from first principles with the same certainty of economic and practical success that can be predicted, for example, from a properly equipped brewery.

Part II., as has been said, is descriptive of the sewerage and sewage treatment methods of some of the chief cities of India and the East. Naturally Bombay receives the chief share of attention, and the description of the different schemes devised to meet the varying circumstances of different parts of that city are full of interest, although the frequent mention of streets and districts not given on the map (Vol. II.) is rather puzzling to the reader unfamiliar with Bombay.

Among the other descriptive accounts those of Calcutta, Rangoon and Benares may be specially mentioned. In connection with the last-named, however, the statement made on page 313, that the dilution of the sewage on entering the Ganges is so great as to *destroy* all pathogenic organisms, cannot be allowed to pass without protest.

The general impression left after reading this book is that it is lacking in a sense of proportion. The author in his anxiety to give all necessary details is apt to leave a somewhat confused impression on the reader's mind. Thus the engineer's report on the sewerage of Rangoon is given in full, down to such details as the necessity for providing spare parts for the ejectors, while only a short introduction of four pages is devoted to a general discussion of climatic, topographical and racial conditions. A knowledge of these is highly necessary for the engineer in the East and appears in this book, to some extent at least, to be taken for granted.

As a storehouse of first-hand information on the subjects with which it deals the book is, however, likely to remain both unique and indispensable.

*Broad Oak, Urmston, near Manchester, England. Dr. Fowler was until recently chemist in charge of the sewage works of Manchester, England.

A New Edition of Rideal's Sewage Treatment.

SEWAGE AND THE BACTERIAL PURIFICATION OF SEWAGE.—By Samuel Rideal, D.Sc. (Lond.), Author of "Water and Its Purification" and "Disinfection and the Preservation of Food." Third Edition. London, England: The Sanitary Publishing Co., Ltd. New York: John Wiley & Sons. Cloth; 6 × 9¼ ins.; pp. 355; 58 illustrations, mostly in the text. $4.

By means of the present revision Dr. Rideal's book becomes the most up-to-date and the best general work on sewage treatment now available. It still consists chiefly of a statement of the problem of sewage treatment and of the principles involved and methods employed in the solution of that problem, together with a review of some of the large number of experiments on sewage. It contains little in the way of description of sewage disposal works. The revision seems to have been made with a fair degree of thoroughness. It covers some events and literature well into 1906.

The general plan of the book is to present an idea of the character of sewage and the changes occurring in it, then to describe the main processes of treatment and their underlying principles. A separate chapter, with more space than in former editions, is given to sewage distribution and distributors, which will be a welcome feature in America on account of the many kinds of distributors in use in Great Britain. There is also a new chapter on sewage outfalls and discharge. The discussion of trades wastes continues to be scanty.

The two earlier editions were reviewed in our issues of Jan. 10, 1901, and July 17, 1902. We are pleased to note that the causes for some minor adverse criticisms in our reviews of those editions have been removed in the present volume.

On p. 225 Dr. Rideal states that the intermittent "filters constructed in New England a few years ago are one by one becoming clogged and inoperative except at very low rates, and it is now evident that they necessitate heavy maintenance charges." This is misleading, particularly as regards clogging. But few New England plants of this kind have been rendered inoperative through clogging, and none, so far as we know, owned by municipalities. The worst troubles have been chiefly due to inefficient management.

WE have moved our main office to 357 Dearborn St., Chicago, from which point all Western orders will be filled. Eastern orders will be filled as heretofore from our New York office, 21 Park Row, N. Y. Orders for the following, which are our own publications, or for the publications of other publishers will receive prompt attention if sent to either office.

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A Book for the Assay Office.

Reviewed by BRADLEY STOUGHTON.*

FIRE ASSAYING.—A Practical Treatise on the Fire Assaying of Gold, Silver and Lead, Including Description of the Appliances Used. By Evans W. Buskett, B.S., Chemist, Ozark Smelting and Mining Co., Coffeyville, Kans. New York: D. Van Nostrand Co. Cloth; 5 × 7½ ins.; pp. 105; 70 illustrations in the text and numerous tables. $1.25, net.

This little book has nothing against it except its brevity. It is clearly and concisely written and well illustrated. The subjects treated include sampling, reagents and fluxes, assay of acid and basic ores, of lead and bullion, methods of handling work and laboratory tests of ores as to their amalgamation, chlorination, cyanidation and concentration, while tables of weights and measures and of certain physical constants of metal, etc., are very useful. The book is not sufficiently complete to serve as a text-book for a student unless supplemented by many lectures, nor could one ignorant of assaying find enough information in it to enable him to learn the subject from this book alone, although there is a good deal of data in connection with machines used and many illustrations which would assist him if used in connection with another book. For an assistant in an assay office who is familiar with the manipulation of assaying, but does not understand the reasons for the different steps, this little book would be very useful to begin upon.

City Impovement.

NEW YORK CITY IMPROVEMENT COMMISSION.—Report to the Honorable George B. McClellan, Mayor of the City of New York, and to the Honorable Board of Aldermen of the City of New York. New York: The Commission (Francis K. Pendleton, Chairman). Boards; 7½ × 10½ ins.; pp. 36; 24 plates.

CAPITOL APPROACHES COMMISSION.—Report to the Common Council of the City of St. Paul. St. Paul, Minn.: The Commission (Louis Betz, Chairman). Paper; 10¾ × 15¾ ins.; illustrated.

As a result of three years' study, the New York City Improvement Commission, has presented a valuable report on much needed improvements in the general street plan of New York City, together with needed additions to its park system and the consideration of various minor matters, such as uniformity in house and street numbering, gas and electric fixtures, location of statutes and monuments, tree planting and cab service. By the aid of text and plans and views, mostly wash drawings, a number of important new thoroughfares are outlined, as well as additions to parks and parkways. An important suggestion is made, deserving of consideration by other cities as well as New York, to the effect that the city be given power to condemn land adjacent to that needed for comprehensive street and park improvements, in order that it may itself profit by the enhanced value of the adjacent property due to improvements. By this means the cost of the improvements, or at least of the land required for them, would be reduced or eliminated by the profit secured by the city. Associated with the Commission as an Advisory Committee were Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, Secretary to the Commission; John A. Bensel, Chief Engineer, Department of Docks and Ferries (present Commissioner of Docks); O. F. Nichols, Chief Engineer, Department of Bridges (present Consulting Engineer, Department of Bridges); and Samuel Parsons, Jr., Landscape Architect, Park Department. Mr. Richard A. Walker was Architect of the Commission. The report is handsomely presented in the way of typography, press work and binding, and forms a notable addition to the rapidly growing number of reports on municipal improvements having the combined motive of adding to the esthetics and the convenience of city life.

The report on approaches to the capitol of Minnesota, made by a committee appointed by the Common Council of St. Paul, deals with a special problem, but one deserving the serious consideration of the people of St. Paul and also of the State of Minnesota. The report quotes some one as saying that the Minnesota State capitol is "a diamond set in a garbage pail." The illustrations in the report clearly show that the surroundings of the new capitol are intolerable to any one with a sense of the dignity and importance of a state capitol building. Small dwellings and even shanties irregularly placed, numerous bill-boards, and generally unkempt premises, are in close proximity to the capitol. The report suggests that a number of the streets be opened up or widened, to give adequate approach to the capitol and also to allow the building to be fully seen from distant points of view. It is proposed that the city acquire the property at its own expense, with the expectancy that the State will bear some of the cost of developing the approaches later on. A number of views of more or less closely related improvements in other cities are included in the report. It is to be regretted that the report is presented in such an awkward form; pages of half the size would have enabled the report to be filed with others of this sort, whereas now it is impossible to file it without damaging it by folding.

*Adjunct Professor, Department of Metallurgy, Columbia University, New York City.

SANITATION IN THE MODERN HOME.—Edited by Jno. K. Allen, Editor of "Domestic Engineering." Chicago, Ill.: Domestic Engineering. Cloth; 5¼ × 7¾ ins.; pp. 271. $2.

Broadly speaking, this book deals with the planning and equipment of houses for health, comfort, and convenience, and for economy of domestic operations. It is designed to be "a suggestive guide to the architect and house owner in designing" homes. For the prospective house owner, and to a considerable extent for any house owner or occupier, the volume should prove valuable. To architectural students and to practicing architects who have not had the benefit of thorough school or office instruction the book should also be useful. It considers the selection and preparation of a building site, the various elements of a house and their proper combination, the laundry, heating, ventilation, temperature control, water supply, both cold and hot, the kitchen, bathroom, lighting, the stable, and "electricity in the modern home." Sanitation would have to be defined broadly to include a number of the items of design or equipment discussed: as an extreme case, carriage jacks may be mentioned. The book contains few technicalities, no illustrations and, said to relate, no index. It covers a broader field than would be expected from its title, but omits any discussion of sewage disposal for country residences.

THE MANUAL OF STATISTICS.—Stock Exchange Hand-Book, 1907. New York: The Manual of Statistics Co. Cloth; 5¼ × 8 ins.; pp. 1064; folding maps. $5.

The present or twenty-ninth issue of this annual follows the same lines as recent issues. That is, it contains useful information regarding railroad, industrial and mining companies and their securities for the use of investors and others interested in stocks, bonds and allied subjects.

THE 20TH CENTURY TOOLSMITH AND STEEL-WORKER.—By H. Holford. Chicago, Ill.: Frederick J. Drake & Co. Cloth; 5 × 7¾ ins.; pp. 240; 117 illustrations in the text and 1 folding sheet. $1.50.

The fact that this book is professedly written by one who has learned through hard experience many details of blacksmithing and toolmaking is no reason why the author should declaim against education, although it may be a partial excuse for poor English and for verbosity. As to the latter, it appears that the book might be [illegible]erially condensed with great advantage to [illegible]ective users. Buried in redundant matter, [illegible]lle a great many items of practical value t[illegible]e mechanic and the apprentice. It is ev[illegible] that the author has had a wide experience [illegible] work and has collected considerable materi[illegible]. There are especially valuable hints on forgi[illegible] hardening and tempering all sorts of tools.

Government Contracts.

A LECTURE ON THE LAW OF CONTR[illegible]S.—By John Mason Brown. Washington: Jo[illegible] Mason Brown. Cloth; 6 × 9½ ins.; 80 pp.; $1.

This book should prove of especial i[illegible]rest to all those engineers and contractors w[illegible] have dealings with the Federal Government or any of its bureaus or offices. The title is somewhat misleading, as it would be impossible to set out the whole law of contracts in a small volume. The real subject of the book is government contracts. The salient points are brought out fully, but the fine points of the law are left to larger and purely legal treatises. The subject-matter of the book was prepared by Mr. Brown for delivery before the Association of American Government Accountants, the aim and desire of the author being to correct some of the misconceptions of law and some of the errors of practice which have so largely characterized the government contract and those who have had to deal therewith.

The presentation of the matter—especially those features and branches with which contractors are so frequently harassed and annoyed—is exceptionally clear. The language is entirely untechnical and the book is so arranged as to give the layman a thorough grasp of the main principles of the law. The citation of cases and departmental rulings is abundant and a vast amount of valuable information is well condensed without sacrifice of matter.

Especial attention should be called to the sections on interpretation and discharge of contracts and on penalties and liquidated damages, the vital distinction between which, usually not understood by the average contractor, is very clearly set forth.

It may be added, in conclusion, that Mr. Brown is Law Clerk to the Comptroller of the U. S. Treasury, and was recently appointed by President Roosevelt as a member of a special committee on government contracts, the duty of which is to revise and prepare contract forms for the various bureaus of the national government. The book therefore has a semi-official character. It has already been adopted by practically all branches of the government.

STANDARD MECHANICAL EXAMINATIONS ON LOCOMOTIVE FIRING AND RUNNING.—Being the Progressive Examinations for the First, Second and Third Years, Which Were Adopted as Standard by the Traveling Engineers' Association. With Answers by W. G. Wallace. Together with Much Valuable Information for Locomotive Engineers. Chicago, Ill.: Frederick J. Drake & Co. Flexible leather; 4½ × 7 ins.; pp. 343; folding and other plates and text illustrations.

This handbook—a very useful collection of illustrated descriptive matter, questions and answers, and "dont's—is very well described in the foregoing abstract from its title page. A historical division covering the evolution of the locomotive, a chapter on economy rules, and 44 pages devoted to fuel oil and the construction and operation of oil-burning locomotives are noteworthy features.

An Announcement of Interest

To Readers of This Page

Will Be Found on Page 36 of the Advertising Section

How to Timber Mines.

Reviewed by E. J. McCAUSTLAND,* M. Am. Soc. C. E.

MINE TIMBERING.—By Wilbur E. Sanders, Bernard MacDonald, Norman W. Parlee, and others. New York and London: Hill Publishing Co. Cloth; 6 × 9½ ins.; pp. 179; 140 illustrations in the text. $2.

This is a most welcome addition to the literature of mining, although its editor makes for it no claim as a treatise on mine timbering. The purpose and scope of the work is best indicated by the following excerpts from the preface:

This book is a collection of papers that have previously been printed in the Engineering and Mining Journal, The Mineral Industry, and the transactions of various societies, the source being stated in a foot-note to each article. The article by Mr. MacDonald was published originally in the Proceedings of the Canadian Mining Institute, and that by Mr. Parlee in the Proceedings of the Canadian Society of Civil Engineers. . . . The last part of the book is made up chiefly of articles that have appeared in the Engineering and Mining Journal during the last two or three years. In the absence of any treatise on this important subject, which is the hand-books and text-books on mining is dealt with only in a superficial way, it has appeared worth while to make the present collection, which is offered not as a complete treatise on the subject, but rather as a series of essays which go fully into many important details. It is hoped that a thorough and systematic treatise on mine timbering will soon be written.

The first of these essays is an article by Mr. Sanders, which appeared in "The Mineral Industry," 1899. This paper, covering 52 pages, is the part of the book which will be of most value to the person seeking fundamental information, since here some of the general principles underlying the subject are considered, although briefly.

Of course, the principles of mine timbering are simple and easily understood, if one is at all familiar with the mechanics and physical properties of materials; but for the student, and especially for the young engineer, a brief, concise and clear statement of conditions involved in the problem under consideration is always an aid to the understanding when entering upon a new field.

Among other things, Mr. Sanders considers the timbering of stations and levels and their connections with both vertical and inclined shafts, as well as the timbering of the shafts themselves. Timbering of working places, posts, cribs and stulls; square sets in stoping, ore chutes, method of framing, etc., are described in a very lucid manner and the text accompanied by complete drawings and illustrations.

A word with reference to the figures throughout the text, not one of which can be called poor: the illustrations are well chosen, and all of the drawings are exceptionally clear and distinct. Many of them give full dimensions and are in every sense complete working drawings. Different methods of framing are described and accompanied by drawings showing the timbers, both in the separated and in the joined condition. The perspective views of shaft timbering are excellent and complete in detail. Altogether, Mr. Sanders' monograph is a valuable one, and the editor has shown good judgment in placing it as an introduction to this collection of articles.

Next in order, and covering 19 pages, is the article by Mr. MacDonald describing the square-set system at Rossland, B. C. In reading this chapter the tyro will need to be warned against that which is obvious to the experienced man, and that is that the system described as in use at Rossland may be entirely unsuitable in a mine with different vein characteristics and different methods of working. If this point is not overlooked, the description of Rossland practice may be of great value. It is given in detail and accompanied by numerous drawings. A discussion of costs reduced to a per ton basis is full of suggestion and helpfulness. The limitations of the square-set system and the various reinforcing devices are very clearly but briefly set forth.

The paper by Mr. Parlee covers 30 pages and includes a description of methods of mining and timbering in large ore bodies, the following individual mines being especially treated: The Le Roi mine, Rossland, B. C., the Old Ironsides, Phoenix, B. C., the Baltic mine, Baltic, Mich., the Atlantic mine, Atlantic, Mich., the Barnum mine, Section 16, and the Soft Ore Hematite, all of Ishpeming, Mich., and the Queen mine of Negaunee, Mich.

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With the exception of the Atlantic mine, which is mined by the stull method, all these workings are in large ore bodies. Mr. Parlee's paper presents in a forcible and striking manner the interrelation of methods of mining and the forms of timbering which are most suitable.

Further chapters in the book deal with special practice at Bingham, Utah, at Lake Superior, in the Coeur D'Alene, at the Chillagoe Mines in Queensland, and in Tasmania. These chapters contain much information of value to the mining superintendent, and furnish much good material for the man who may serve his profession well by writing "a thorough and systematic treatise on mine timbering."

In conclusion, the book is well worth the price asked for it, and it will no doubt find a ready and extended sale.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 192. The Potomac River Basin. Geographic History—Rainfall and Stream Flow—Pollution, Typhoid Fever, and Character of Water—Relation of Soils and Forest Cover to Quality and Quantity of Surface Water—Effect of Industrial Wastes on Fishes. By Horatio N. Parker, Bailey Willis, R. H. Bolster, W. W. Ashe, and M. C. Marsh. Pp. 364; ten plates (one in pocket) and two text illustrations.

No. 193: The Quality of Surface Waters in Minnesota. By R. B. Dole and F. F. Wesbrook. Pp. 171; seven plates and four text illustrations.

No. 194: Pollution of Illinois and Mississippi Rivers by Chicago Sewage. A Digest of the Testimony Taken in the Case of the State of Missouri v. the State of Illinois and the Sanitary District of Chicago. By Marshall O. Leighton. Pp. 369; two plates and five text illustrations.

The value of this well-known series of publications is greatly increased by the additions noted above. The study of the Potomac River Basin (No. 192) is the most comprehensive investigation and report of its kind ever issued. The main river and its tributaries are taken in considerable detail, along the lines indicated by the sub-title.

Paper 193 "outlines the general characteristics of surface waters in Minnesota and the various factors that tend to modify" their character. It is the result of nearly two years of cooperative work by the U. S. Geological Survey and the Minnesota State Board of Health.

Mr. Leighton's digest (No. 194) of the testimony in the famous Chicago Drainage Canal case is most welcome. It puts the gist of 8,000 printed pages of testimony into some 350 pages of readable and readily comprehensible matter. At the same time it assembles in compact form the opinions on water pollution, typhoid fever, etc., held by many of our leading engineers, chemists, bacteriologists and pathologists.

Structural Stresses.

STRESSES IN STRUCTURES AND THE ACCOMPANYING DEFORMATIONS.—By A. H. Heller, C. E., Professor of Structural Engineering, Ohio State University. (Columbus, O.: The Varsity Supply Co., 1602 North High St.) Cloth; 5¾ × 9 ins.; pp. 324; 217 illustrations in the text.

The untimely death of Prof. A. H. Heller left uncompleted what promised to be an unusually meritorious treatise on stresses in beams, columns and framed structures. The completed portion, which has just been published, includes something more than half, apparently, of what the entire work was to comprise. It covers the principles of statical analysis, stresses in beams and in columns, and stresses in simple trusses. To condense into a volume of little over 300 pages so much matter as this is in itself an achievement. And the work is extremely well done. Simplification and conciseness are secured by the most desirable method: omitting the more abstruse or less directly useful researches, and referring to other works for them; giving so much of each branch as is necessary to a thorough command of the subject for practical utilization. This is not to be taken as implying that the author substitutes general rules, approximate methods, or instructions to the practical man, for exact analysis. On the contrary, in several details the present text goes farther than most other American works on structures. This applies, for example, to the discussion of bending when the plane of the moment does not coincide with a principal axis of the cross-section of the beam—a subject so neglected in American literature that Prof. L. J. Johnson found it expedient to present it in a paper before the American Society of Civil Engineers a year ago. It applies also to the study of columns under central and eccentric loading. Indeed, the author's chapter on columns is by far the best text-book discussion of the subject with which we are familiar, and is alone sufficient to assure the book a claim to careful study. A good knowledge of his subject and a sound view of the underlying facts and conditions are exhibited generally in the work. A full statement of how the phenomena of flexure vary from those expressed in the commonly-used formulas, and remarks on fatigue action and on the elastic properties of iron and steel merit special commendation.

Wiring Buildings for Electric Lights.

ELECTRIC LIGHT WIRING.—By C. E. Knox, E.E., M. Am. Inst. E. E. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 219; 119 illustrations, mostly in the text. $2, net.

The author has considered the wiring of buildings by the two and three-wire systems only, as the four and five-wire systems have never come into general use in this country. The advantages and disadvantages of the first cost of two and three-wire systems for feeders and mains are first discussed. The different generating systems, such as double-generator, single-generator with a balancer set or with compensating transformers are then very simply outlined by the aid of diagrams. Methods of wiring buildings approved by the National Board of Fire Underwriters, and the proper use of conduit, cables, tubes, porcelain fittings, etc., are described. The author has included considerable information on the manufacture of interior conductors with the National Code requirements, all of which assists one to judge of the quality of goods offered.

In Chapter IV. there is shown the development

TRAUTWINE'S
CIVIL ENGINEERS' POCKET BOOK

15th Edition, 1906
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JOHN WILEY & SONS
Scientific Publishers
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NEW YORK CITY

of the present types of fuses. In the following chapter the outgrowth of modern panel and control boxes, with their bus bars, enclosed fuses, knife and push-button switch compartments, is traced from the old 1892 types of distribution boards where the connections were made at the back and whose sole fire protection was a slight asbestos lining.

The general features of the design of feeders and mains is taken up in 14 pages. Here the terms, feeders and mains are used in the latest and most usual way. "Feeder" designates a single set of conductors beginning at a main switchboard and ending at a local distribution center. A "main" supplies the minor and branch circuits from the feeder. The design of feeders is taken up with reference to the effect of certain problems, such as control of groups of lights from the main switchboard, control of hall lights from the main boards, maximum load per feeder, the best maximum limit in size of conductors, and the percentage of total losses to be allowed in feeders and mains.

After a short chapter on the testing of insulation resistances, there is laid down the theory of computing sizes of conductors for direct-current systems, based on the data made available by the study of conditions and the solution of the problems mentioned above.

The peculiar phenomena of alternating current-circuits, self and mutual induction, skin effect, capacity, are explained briefly, simply and non-mathematically. The effect of these phenomena on wiring design is pointed out, with examples of what has happened when they were not properly taken into account.

There are 44 pages of examples, drawn from the author's practice as a consulting electrical engineer, showing how these principles and calculations have been actually carried out. In these specific instances are the Park Row Building, Manhattan Hotel, a large private residence and an apartment house, all in New York City. There are also given wiring plans of a summer hotel and a club building, and the specifications for electrical work in a large suburban residence.

Such line construction, both overhead and underground, as seems likely to be encountered in isolated work is considered in the latter part of the book. National Code specifications and best engineering practice outline the requirements for poles, gains, cross-arms, pins, braces, guards, insulators; iron, wood, fiber and tile conduits.

The Appendix contains 27 black and white cross-section diagrams, showing the best sizes of Sprague lined and loricated unlined conduit for various sizes and arrangements of conductors.

The volume presents the subject of building wiring in actual practice. Few technical schools can afford time to give students the practice of wiring as herein treated. For this reason the book should be of especial use to young engineers who have not had time or opportunity to acquire a system of practice for themselves. To those who have had little opportunity to approach electrical engineering mathematically, this book should be equally useful. The absence of ultimate reasons and complete mathematical evolutions of the various steps will work no hardship. The man with the degree should have already passed such, and the others will accept the results without the burden of proof.

Hoisting and Transporting Machinery.

THE MECHANICS OF HOISTING MACHINERY.—Including Accumulators, Excavators and Pile-Drivers. Text-Book for Technical Schools and a Guide for Practical Engineers. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Authorized Translation from the Second German Edition by Karl P. Dahlstrom, M.E., Late Instructor of Mechanical Engineering at the Lehigh University. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5½ × 9 ins.; pp. 332; 177 illustrations in the text. $3. net.

DIE LUFTSEILBAHNEN.—Their Construction and Use. By P. Stephan. Berlin, Germany: Julius Springer. Paper; 6¼ × 9 ins.; pp. 193; 194 illustrations in the text and 4 folding tables. 7 marks; American price, $2.80.

Machinery for handling, lifting and transporting materials has undergone a tremendous development in the last two or three decades. Prior to that, nearly all of the elements of which such machinery is built up were in existence. These are described and analyzed in thoroughgoing manner in the work of Weisbach and Hermann, which Mr. Dahlstrom has translated. But progress in the later period has been far more than mere combination of these elements in more complex plants. New problems and new performances give to modern hoisting and conveying machinery a radically different aspect. The two subjects of traveling cranes and platform elevators, for example, would alone merit each a volume similar to that which Prof. Weisbach wrote to cover the entire field. The present volume, therefore, has mainly antiquarian interest, when viewed as a treatise on hoisting machinery. Its analysis of many elements of hoisting machines, however, is still of full validity, and can serve as a model to authors of modern works on the subject.

The volume of Mr. Stephan on aerial rope tramways is excellent as a descriptive review of one division of the subject of cableways. Stationary cableways of the type much used in this country for earthwork receive very insufficient treatment, but this is rather natural for the reason that the book, apparently, is designed mainly as a work on rope tramways, the fixed plants which serve so admirably for transporting moderate amounts of bulk freight in difficult country. The work is well illustrated, and the text explanation is good. It is weak on the side of analytical study, contrasting radically with the first-noted volume in this respect, and serves as a guide to design principally by showing many specimens of actual construction.

Publications Received.

THE AIR OF THE NEW YORK SUBWAY PRIOR TO 1906.—By George A. Soper. (Reprinted from "The Technology Quarterly," Vol. XX., No. 1, March, 1907.) Paper; 7 × 10¼ ins.; pp. 58 to 118; 23 illustrations in the text.

BULLETINS, BUREAU OF THE CENSUS.—S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11⅓ ins.

No. 73: Census of Manufactures: 1905. Electrical Machinery, Apparatus and Supplies. Pp. 73; 11 plates.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 294: Zinc and Lead Deposits of the Upper Mississippi Valley. By H. Foster Bain. Pp. 155; 16 plates (one in pocket) and 45 text illustrations.

No. 296: Economic Geology of the Independence Quadrangle, Kansas. By Frank C. Schrader and Erasmus Haworth. Pp. 74; six plates (one in pocket) and three text illustrations.

No. 314: Report on Progress of Investigations of Mineral Resources of Alaska in 1906. By Alfred H. Brooks and others. Pp. 235; four plates and nine text illustrations.

No. 315: Contributions to Economic Geology, 1906. Part I.—Metals and Nonmetals, except Fuels. S. F. Emmons, E. C. Eckel, Geologists in Charge. Pp. 505; 4 plates and 20 text illustrations.

DENATURED OR INDUSTRIAL ALCOHOL.—A Treatise on the History, Manufacture, Composition, Uses, and Possibilities of Industrial Alcohol in the Various Countries Permitting Its Use, and the Laws and Regulations Governing the Same, Including the United States. By Rufus Frost Herrick, Consulting Chemist and Chemical Engineer. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 516; 163 illustrations, mostly in the text. $4, net.

EKONOMISKA TRANSPORTMEDEL SAMT ANORDNINGAR FOR LASTNING, LOSSNING OCH OMLASTNING.—By Sven Carlson. Stockholm, Sweden: The Author. Paper; 9¼ × 12¼ ins.; pp. 22; 67 illustrations in the text.

ELECTRIC ROADS.—By Charles N. Wilson, President American Engineering Co., Indianapolis, Ind. Paper; 3¾ × 8¾ ins.

Articles on the Building and Development of Electric Roads in the Central West. (Published in "The Tradesman," Chattanooga, Tenn.). Pp. 16.

Why Forty-Nine Projected Electric Roads Fail and the Fiftieth Succeeds. (From "Interurban Railway Journal," Convention Number.) Pp. 11.

ENGINEERING SOCIETY, UNIVERSITY OF TORONTO.—Transactions, No. 20, 1906-1907. Toronto, Ont.; The Society (A. A. Kinghorn, Secy.). Paper; 5¾ × 8¾ ins.; pp. 247; folding plates and text illustrations. 50 cts.

ENTWERFEN UND BERECHNEN DER DAMPFMASCHINEN.—A Text-book and Manual for Students. By Heinrich Dubbel. Second edition, enlarged. Berlin, Germany: Julius Springer. Leather; 6¼ × 9½ ins.; pp. 452; 427 illustrations in the text, and one folding plate. 10 marks; American price, $4.

FORMELN UND TABELLEN DER WAERMETECHNIK.—For Use in Tests on Steam, Gas and Metallurgical Plants. By Paul Fuchs. Berlin, Germany: Julius Springer. Leather; 5½ × 8½ ins.; pp. 43; 17 tables. 2 marks; American price, 80 cts.

GAS AND OIL ENGINES.—A Treatise on the Design, Construction, and Working of Internal-Combustion Engines. Operated by Gas from Town's Mains, Blast Furnaces, Pressure and Suction Producers, as well as by Oil and Petrol. By Horace Allen. Manchester, England: The Scientific Publishing Co. Cloth; 5½ × 8¾ ins.; pp. 548; 243 illustrations in the text and one folding plate. 12s. 6d., net; American price, $5.

INTERNATIONAL ASSOCIATION OF [illegible]UNICIPAL ELECTRICIANS.—Proceedings of the [illegible]enth Annual Convention. Held at New Haven, [illegible]nn., Aug. 15, 16 and 17, 1906. (Frank P. Foster[illegible]y., Corning, N. Y.) Cloth; 5¾ × 8¾ ins.; pp. [illegible] Illustrated.

IRON AND STEEL IN COMMERCE.—S[illegible] List of Books with References to Periodicals. [illegible]pplied under the Direction of Appleton Prentiss[illegible]k Griffin, Chief Bibliographer. Washington, D. [illegible] Pub. Doc. Paper; 7¼ × 10 ins.; pp. 25.

KANSAS CITY OUTER BELT AND ELE[illegible]IC RY.—Issued by the Kansas City, Mexico & [illegible]rient Ry., Kansas City, Mo. Paper; 12½ × 9½ [illegible] pp. 14; illustrations only.

MASSACHUSETTS CIVIL SERVICE CO[illegible]ISSION.—Annual Report from Oct. 1, 1905, to S[illegible]30, 1906, inclusive. Boston, Mass.: Pub. Doc. (N[illegible]). Paper; 5¾ × 9¼ ins.; pp. 197.

OPEN HEARTH STEEL CASTINGS.—By [illegible]M. Carr. (Compiled from a series of articles by [illegible]e author, written for and published by "The Iron [illegible]Trade Review" and "The Foundry.") Cleveland, O.: The Penton Publishing Co. Cloth; 5¼ × 7¾ [illegible], pp. 118; 19 illustrations in the text. $1.50.

OVERHEAD CONTACT LINES.—For Electric Railways Using the Sliding Bow. By Joseph May[illegible], M. Am. Soc. C. E., Author of "The Stiffening Sy[illegible]s of Long Span Suspension Bridges," etc. New York: The Author (1 Broadway). Paper; 6 × 9 ins.; [illegible]64; folding plates and text illustrations.

PROFESSIONAL PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11⅓ ins.

No. 57: Geology of the Marysville Mining District, Montana. A Study of Igneous Intrusion and Contact Metamorphism. By Joseph Barrell. Pp. 178; 16 plates (two in pocket) and 9 text illustrations.

QUICK RULES FOR HEATING AND VENTILATING.—By William J. Baldwin, Jr., Heating and Ventilating Engineer. New York: The Author (1181 Broadway). Cloth; 4½ × 6¼ ins.; pp. 24. $1.

RHODE ISLAND STATE BOARD OF HEALTH.—Annual Report for the Year Ending Dec. 31, 1901, and Including the Report upon the Registration of Births, Marriages and Deaths in 1900. Providence, R. I.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 305 + 300, folding and other plates.

ST. MARYS FALLS CANAL, MICHIGAN.—Statistical Report of Lake Commerce Passing through Canals at Sault Ste. Marie, Michigan and Ontario during Season of 1906. With a Supplementary Report of Commerce Passing through the Detroit River. Prepared under direction of Col. Charles E. L. B. Davis, Corps of Engineers, U. S. Army. Paper; 6 × 9¼ ins.; pp. 24; folding and other plates.

SOME CONDITIONS INFLUENCING CONSTANCY OF VOLUME IN PORTLAND CEMENTS.—By Edward DeMille Campbell and Alfred H. White. (Reprinted from The Journal of the American Chemical Society, Vol. XXVIII., No. 10, October, 1906.) Paper; 5¾ × 9¼ ins.; pp. 1273 to 1303; one plate.

STATE BOARD OF HEALTH OF CONNECTICUT.—Annual Report for the Year 1906, with the Registration Report for 1905 Relating to Births, Marriages, Divorces and Deaths. New Haven, Conn.: Pub. Doc. (No. 25). Cloth; 5¾ × 9¼ ins.; pp. 292.

A STUDY OF SOME COLORADO COALS.—A COMPARISON OF SOME COALS FROM BOULDER, ROUTT AND DELTA COUNTIES.—By William P. Headden. (Proceedings of the Colorado Scientific Society, Vol. VIII.) Denver, Colo.: The Society. Paper; 6¼ × 9½ ins.; pp. 281 to 299.

SUBSTITUTION OF THE ELECTRIC LOCOMOTIVE FOR THE STEAM LOCOMOTIVE.—By Lewis B. Stillwell and H. St. Clair Putnam. A Paper Presented at the 214th Meeting of the American Institute of Electrical Engineers, Jan. 25, 1907. With Discussion. (Reprinted from Vol. XXVI. of the Transactions). New York: American Institute of Electrical Engineers (33 West 39th St.). Cloth; 5¾ × 9¼ ins.; pp. 301; illustrated. $1.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.—Bulletin No. 17, Corps of Engineers, War Department. A. Mackenzie, Brig. Gen., Chief of Engineers, U. S. Army. To Supplement the Information Given upon the Charts of the Great Lakes, and Issued with Those Charts from the Office U. S. Lake Survey, Detroit, Mich. Paper; 7¾ × 10 ins.; pp. 364; folding and other plates.

A TEXT-BOOK OF TOPOGRAPHICAL DRAWING.—By Frank T. Daniels, A. M. B., Author of "A Text-Book of Free-Hand Lettering." Boston, Mass.: D. C. Heath & Co. Cloth; 7¼ × 5¾ ins.; pp. 144; 56 illustrations in the text and 10 plates. $1.50.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 182: Flowing Wells and Municipal Water Supplies in the Southern Portion of the Southern Peninsula of Michigan. By Frank Leverett and Others. Pp. 292; 5 plates and 44 text figures.

No. 188: Water Resources of the Rio Grande Valley in New Mexico and Their Development. By Willis T. Lee. Pp. 59; ten plates and two text figures.

No. 191: The Geology and Water Resources of the Western Portion of the Panhandle of Texas. By Charles N. Gould. Pp. 70; seven plates and three text illustrations.

No. 196: Water Supply of Noma Region, Seward Peninsula, Alaska, 1906. By John C. Hoyt and Fred F. Henshaw. Pp. 52; six plates and one text figure.

No. 200: Weir Experiments, Coefficients and Formulas. (Revision of Paper No. 150.) By Robert E. Horton. Pp. 195; 38 plates and 17 text illustrations.

WATER-WORKS MANAGEMENT AND MAINTENANCE.—By Winfred D. Hubbard, Assoc. M. Am. Soc. C. E., and Wynkoop Kiersted, M. Am. Soc. C. E., Consulting Engineer. New York; John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9 ins.; pp. 429; 114 illustrations, mostly in the text. $4.

WHOLESALE PRICES, 1890-1906.—Bulletin of the Bureau of Labor, No. 69, March, 1907. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 239 to 477.